ENGINEERING NEWS

The findings of the Railroad Commission as to the Roslindale disaster was submitted to the Legislature on Wednesday of this week. We are indeed gratified to see that the Commissioners speak with no uncertain sound. They find that the disaster was caused solely by the breaking of the hangers of the bridge. The neglect and bad management of the railroad company, which are responsible for the disaster, the Commissioners rank as criminal. Some of the detailed statements (we have not yet the full report before us) are as follows:

The contract for rebuilding the bridge in 1876 was made without proper examination as to the standing of the contractor. Those who acted for the corporation in making the contract had not sufficient knowledge of iron bridge building to enable them to pass intelligently upon the design and specifications. The design and specifications for the bridge were not such as should have been accepted. The bridge was constructed practically without superintendence on the part of the corporation, and the corporation neglected to preserve a copy of the specifications, drawings, and strain sheets. The tests of the bridge were not made in the presence of any one acting for the corporation who was qualified to judge of their value. From the time of the construction of the bridge, to the day when it fell the railroad company had caused it to be examined by one man only, who, year after year, passed over vital parts of the bridge without realizing that they were of importance. This man had been in the employment of the corporation for a long series of years. His trade was that of a machinist. He had not been educated as a civil engineer, and the management had abundant reason to know that he was not qualified, and had had no opportunity to qualify himself to do the work assigned to him with reference to this bridge. The series of tests of the bridge recommended by the Board in 1881 was not made. In the erection and inspection of bridges the management of a railroad is bound to exercise the utmost care. Had such care been exercised there is every reason to believe that the disaster would have been prevented.

"On the 32nd page of the last report of the Commissioners is the following: 'The Board renews the expression of its belief that a preventible accident is a crime.' Notwithstanding the repeated warnings of the Board, the spaces between the ties on this bridge were far too great for safety. Notwithstanding the recommendation of the Board in 1881, no suitable guard rails or guard timbers were placed upon the bridge. The Westinghouse automatic air brakes, a safety appliance remarkable alike for its simplicity and effectiveness, and long ago approved and adopted by all leading railroads was not in practical operation on this train neither was the train furnished with a sufficient number of brakemen to comply with the requirements of the statutes."

The Commissioners also say that the accident furnishes another proof of the necessity of abolishing the deadly car stove. They do not, in the brief abstract before us, state explicity that expert inspection at any time could have readily detected the old breaks in the hangers, and would have been likely to, but from the general tone of the report we infer that this is either stated explicity, or by inference.

The reference to the non-use of automatic brakes will be seen from the other contents of this issue to be not all that might be desired in such a report, since it was not simply a general defect in the equipment brought into prominence by the disaster, as was the very bad bridge floor, but was a direct contributing cause to the disaster, and a more important one than the fall of the bridge itself. Moreover, in the character of the bridge floor, bad as it was, the Boston & Providence Railroad has plenty of good company all over the country, our bridge floors being one of the most defective parts of average railway construction; while in the non-use of automatic brakes the company were away behind general practice, and with little or no respectable company. This is the more to be regretted and wondered at because the Boston & Providence, we think we are correct in stating, early showed an intelligent interest in the new automatic brake, while it was new, and was one of the first roads to show an active interest in it and afford facilities for tests.

In this, as in many other ways, they have shown a real disposition to have things first-class and in good order, as we have stated before, but the same horrible spirit of economy for mere economy's sake, without other reason or excuse which made them reluctant to throw away the less worn half of a bridge because the other half was clean worn out, made it too hard a pull for them to throw away the old style brakes while they were still capable of service. The consequence is that, while every other first-class road in the country has long since had nothing else but automatic brakes in use, the Boston & Providence has less than two-thirds of its 150 cars and a very much less proportion of its passenger engines equipped with the better brake. At least, these correspond to the definite figures as to its equipment which lie before us, and which we believe to be authentic, but which we hesitate to quote in greater detail, as they may contain some errors. The appalling consequences of this latest case of "I see the right, and approve it, but follow the wrong," are set forth more fully on the editorial page.

A personal visit to the Poughkeepsie bridge this week shows work progressing very favorably. Of the four river piers, No. 2, or the one nearest the western bank of the river, is down to a point about 96 ft. below low-water; at this pier a coffer-dam has been sunk surrounding the old masonry, a concrete base put in for the enlarged pier required for the present plan and after the removal of several more courses of the old work all will be ready for the masons. At Pier No. 3 the dredging in the pockets is carried to 120 ft., or about where the foundation is to rest in the hard gravel; the old crib at this point commenced to sink last Sunday after its long rest, and is now settling down in very good shape towards its final resting place. The location and settling in place of the new crib for Pier No. 4 has been attended with considerable difficulty; the water is about 55 ft. deep at this point and the presentation of some 3,000 sq. ft. of crib surface to unusually strong tides and spring freshets has at three separate times broken away the anchorages, the crib at one time descending the river as far as Blue Point. This crib is now in place and secured by over twenty 1⅛-in. steel cables attached some to heavy crib-anchors and others to large mushroom anchors churned down into the mud back of clusters of piles, the latter driven about 80 ft. into the mud.

The crib anchors are very effective, being made of 3-in. plank piled log-house fashion, so as to enclose a cube of 6 ft. each way, and held together by 8 bolts passing through the corners and sides. These boxes are floored and ceiled with similar plank, filled with broken stone and the hemp bridles to which the anchor cable is attached are secured to eyes in the ends of the four corner-bolts. They are launched from a scow by being first placed on greased inclined ways and secured by ropes before the stone filling is put in; when filled and all attachments made the scow is towed into position, the ropes cut and the box goes overboard. They weigh about 14 tons in the air and can be lifted again by the hoister on the pile-driver when this is necessary.

The crib for Pier No. 5, or the last one in the river, is built but not yet towed into position. The main-shore piers are completed on both sides and further masonry laid in some of the shore pedestals. Mr. J. F. O'Rourke is chief engineer for the Union Bridge Co., and is in direct charge of the difficult work now in progress; Mr. P. P. Dickinson is chief engineer of the Poughkeepsie Bridge Co., and Mr. A. B. Paine, of the Manhattan Bridge Co., for which organizations the Union Bridge Co., of New York, is erecting this bridge. The Atlantic Dredging Co., of Brooklyn, has the contract for dredging down the piers; Messrs. Ross, Sanford & Baird are driving the piling, erecting the false-works (some of which is up on the East side,) and are to erect the superstructure; Messrs. Dawson, Symmes & Usher are building the masonry and foundations, and the United Lumber Co., of Buffalo, N. Y., is furnishing the 12 million feet B. M. of hemlock lumber required for the cribs, etc.

The Construction Committee of the Aqueduct Commission have been discussing the question, very interesting to contractors and the City, of what is to be done with the excavation and back-filling outside of the "normal line" of the tunnel section. Chief Engineer Church is said to favor some general rule covering this condition of affairs, but Corporation Counsel Lacombe and a majority of the Commission oppose any concessions and have agreed to abide strictly by the letter of the contract which allows—nothing beyond this normal line. Rumor says that the reason for so doing is that the contractors will sue the city anyhow for from $800,000 to $1,200,000 for "extra work done under the orders of the chief and division engineers," and it is policy to allow them as little as possible at this stage of the game.

We are indebted to Mr. Rundlett, City Engineer of St. Paul, for the following data relating to the new bridge over the Mississippi at that city and the substructure is now being advertised as open to contract. The total length of the bridge is about 1,800 ft.; width of roadway, 28 ft. 4 in. and two sidewalks of 8 ft. 1 in. each. There are 4 river piers and 25 masonry piers, etc., on shore; the river piers are about 60 by 6 ft., are comparatively low and are founded on piles. The quantities are given as follows:—Masonry, 6,500 cu. yds.; concrete, 1,100 cu. yds.; rip-rap, 3,500 cu. yds.; piling, 56,000 lin. ft.; timber, 206,000 ft. B. M.; excavation, 6,000 cu. yds. Bids for the superstructure will be invited in a few weeks. It is proposed to complete the foundations by Nov. 15, 1887, and the entire bridge by July 1, 1888.

Gen. Hutchinson in his sixteenth quarterly report on the Forth Bridge says, that to date 465,000 cu. ft. of granite have been delivered and 433,700 cu. ft. set; about 103,600 cu. ft. of rubble masonry and concrete-work have been built. The crossings of the 8 ft. tubes on the Inch Garvie piers are practically complete; 36,400 tons of steel have been delivered, 3,393 tons since last report. The average number of men employed during last quarter was 3,280. In the high winds of December and January, the maximum pressure registered on the large gauge were 9, 10 and 15 lbs.; and on the small gauge, 20, 21, 26 lbs. per sq. ft. No serious gale has occurred, but due precautions are being taken, by the use of steel girders, wire rope and chains, to secure the incomplete portions against any undue strains. On the north pier the vertical columns and their diagonal struts have been built up to their full height of 350 ft. above mean sea-level; the upper lattice member is yet to be put on to raise it to its finished height of 363 ft. The south pier is only a few feet behind the north in height; the central pier is nearly half its full height. The lower members of the cantilevers are beginning to be prominent, and they now extend from 120 to 150 ft. beyond the base of the piers.

The St. Lawrence river, Canada, has overflowed and Montreal has been flooded, in some parts to a depth of seven feet. Much damage has been caused by ice and large sections of country have been flooded. The Ohio and Potoka rivers, in Indiana, have also overflowed. The Grand Trunk and Louisville, Evansville & St. Louis Air Line railroads have been flooded. Four highway bridges have been wrecked, and one injured. Several buildings have been injured or destroyed by ice. Cyclones have occurred in Missouri, Arkansas, Kansas and Kentucky.

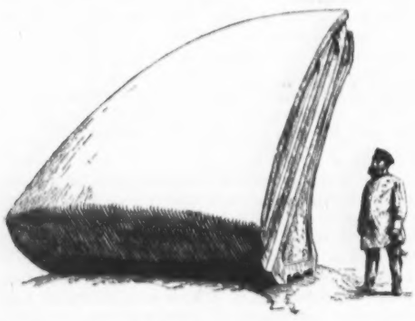
The most serious accident of the week occurred April 21 and was due to a collision on the Cascade division of the Northern Pacific Railroad, near Clealum, Wash. Ter. A west bound train, pushing a flat car carrying laborers, ran into an east bound engine. Six men were killed and 18 injured. It was another case of the careless handling of construction trains, which seems to be inevitable. There was supposed to be a flag out, but there was not.

It is reported that Col. J. T. Dodge, the Chief Engineer of the Montana Central Railroad, proposes to practically test the "bottom heading" system of driving in the Wickes tunnel. This 6,150 ft. of tunnel is to be completed, according to the contract with Larson, Keefe & Co., by May 15, 1888. Col. Dodge is made to say by the Helena *Herald* that with this system he expects an "advance of 600 ft. per month with two sets of drills;" which probably means working from both ends with two drilling plants. The further claims put in are the advantages of working in 200 ft. sections of tunnel; better drainage; avoiding underpinning and the decreased danger of injuring the roof by using the heavy charges at the bottom of the tunnel, thus also loosening the rock above, and rendering it easier to dislodge. If the "bottom heading" is really to be tested here, the results will be watched with much interest by tunnel-men.

Special Railway Car for Transporting Gruson Armor-Plate.

The accompanying illustration of the railway car used for transporting the Gruson armor-plates, is made from a photograph for which we are indebted to the courtesy of Capt. Piorskowski, who represents Mr. H. Gruson in the United States.

The car was especially designed and constructed for this work and has been actually used in the transport of test-plates from Buckau-Magdeburg, Germany, to Spezzia, Italy; in this service the car passed over the St. Gothard railway with all its spirals and intricacies of line. The load to be carried is distributed over four cars articulated as shown in the diagram by curved connecting beams



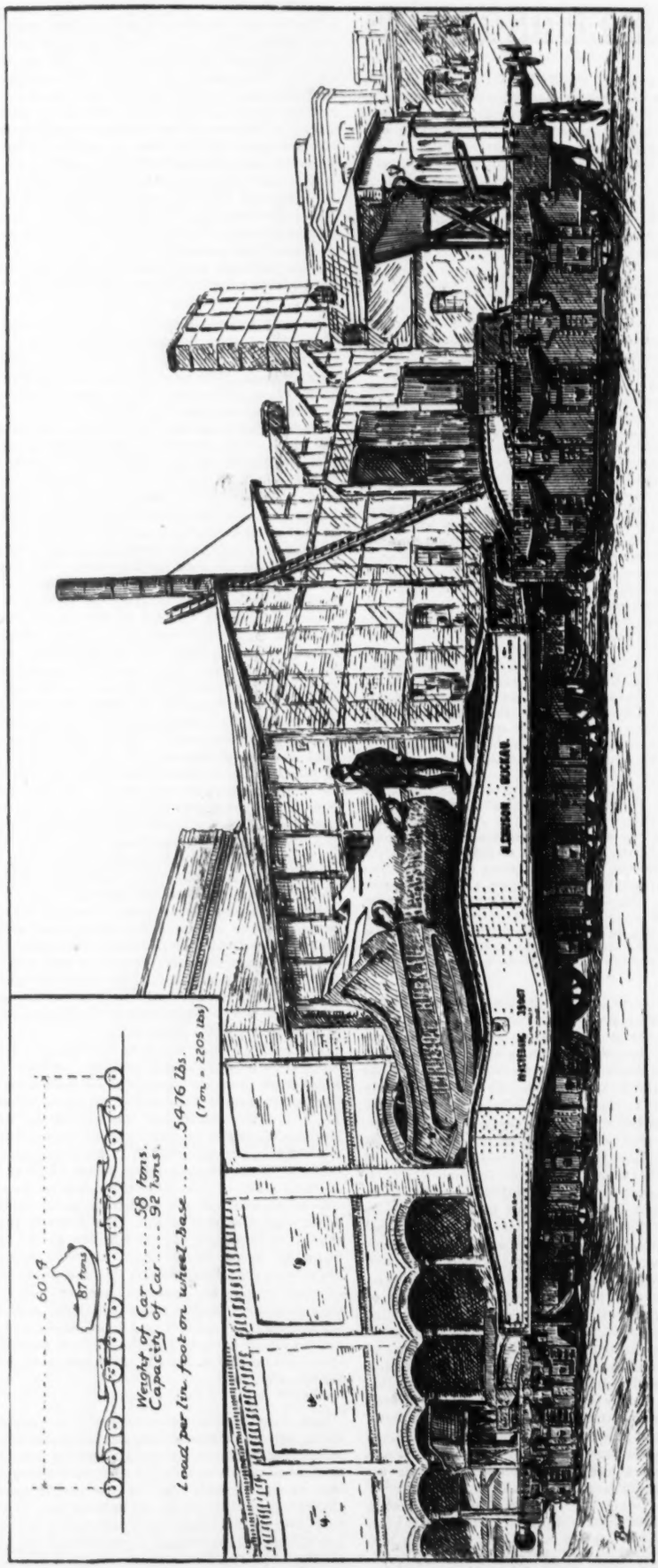
Gruson Armor-Plate.

pivoted; the combined car weighs 58 tons very nearly, or 58,000 kilog., and measured from end-axles, the length is 60.35 ft. The capacity of the car is 92 tons.

The armor-plate is carried on the central bridge or connecting member, the load being supported upon two heavy transverse built beams uniting the two curved members. The plate carried to Spezzia, and used in the very successful test of April to June, 1886, against the 100-ton 43 cm. Armstrong gun, weighed 86.56 tons; it was 49.21 in. thick in the deepest part measured at right angles to its surface, and 33.56 in. at the thinnest or upper part; measured vertically the plate was 10 ft. high. This shield was made with an interior of cast mottled iron and an exterior face of about 2 in. of chilled white iron. Each shield segment covers an angle of 24°, so that 15 of them will complete a circle 33 ft. in diameter; each segment is rounded in such manner that a horizontal section would present a series of curved surfaces somewhat like a section of a melon. Two semi-circular plates of 26-in. chilled cast-iron form the roof of a complete turret of the Gruson type.

The view is taken at the works of Herr Gruson at Buckau-Magdeburg, and the loading is done by the 150 ton specially devised cranes with which these works are provided. The car is made of iron and steel, and both plate and car were designed to meet the railway requirement of 3 m. (10 ft.) as the extreme permissible width. The plate rests on heavy, shaped timber cushions, and the handles seen are simply wedged into prepared sockets and used in setting up the plates. Capt. Piorskowski, in answer to questions, says that the joints of the plates are accurately milled, and the last plate put into a turret is keyed; no bolts or other fastenings are necessary, as the shape and mass of the plates themselves tend to hold them firmly together. In early experiments zinc was poured in to make a watertight joint, but under the enormous impact of the projectiles hurled at these plates the zinc squeezed out like wax, and its use was abandoned. When set up these turrets are now heavily covered on the inside and outside faces with ordinary paint mixed with ground cork; this preparation makes the joints practically water-tight and prevents sweating from the inner face.

The weight of this car and its load, without any other accessories, when equally distributed over its total wheel-base amounts to about 5270 lbs. per lin. ft. of this base, or to 26,502 lbs. concentrated upon the 12 axles. This distributed load is excessive when compared with the 3300 lbs. per lin. ft. of our heaviest engines; and the heaviest concentrated load on one pair of wheels that we can find on record in this country is 25,500 lbs. In this connection we should mention that the above loads were calculated from the



Special Car for Transporting the Gruson Armor-Plates.

actual weight of the armor-plate, while the load given upon the diagram accompanying the car is based upon the stated maximum *capacity* of the car.

Water Pipes.

Mr. A. H. Howland, Member of the Engineer's Club of Philadelphia, in a paper lately published by the Club, speaks of the subject of water-pipe briefly abstracted as follows:

After stating that in this progressive age the ancient history of water conduits is of little value in ascertaining the best and most suitable article for present wants, the author proceeds directly to the consideration of the various types in use to-day; and as far as his power and experience permits, to point out their merits and defects. In the order of proportionate use these would rank as follows:—Cast iron; riveted wrought-iron shell, lined and coated with cement mortar; lap-welded or riveted wrought-iron coated with asphaltum or protected by various forms of metallic coating or oxidation of the surface; wooden pipes; earthen-ware pipes and composition pipes.

Cast Iron Pipe.—Cast- iron is doubtless the standard. The first thing to be considered is a proper adjustment of weight and dimensions (good material being presupposed) to the duty required; to use say 6 in. pipe weighing 42 lbs. per lin. ft. when 30 lbs. pipe would do, simply because this was ancient practice, is to waste money and show a lack of technical and practical knowledge; yet this is sometimes done. The static pressure is the first element to be considered in the adjustment of weights, though it must be remembered that a minimum thickness of pipe is fixed by the conditions of manufacture, and too thin pipe will break in handling and transport. The author thinks he is within reasonable bounds in stating that the minimum practical thickness of any pipe under 24-in. diameter will give sufficient material to withstand a pressure of 300 lbs. or more per sq. in. For ordinary pressures, as few exceed this limit, it would seem that the minimum thickness would be sufficient for all cases. But a pipe is subjected to extraordinary pressures. First comes external pressure due to a heavy load and unequal bearing in the trench; this can hardly be foretold, and we must look for safety to the pipe-layers and be sure they provide full and efficient bed for the pipe in all cases; this element will not then demand a thickening of the pipe. The external load is very rarely more than one-fifth the resisting strength of a properly bedded pipe and thus need not be feared.

But the next, and most important extra strain on the pipe is that due to water-hammer, and we here enter upon a little known subject. It is easy to calculate the momentum of a given column of water flowing with given velocity, and the pressure caused by instantly stopping that flow; but the effect of a gradual stoppage has not yet been formulated. As it is impracticable to design works calculated to resist the greatest conceivable water-hammer, the next question is, how much we should provide for, and how much intelligence and care can be expected from employés and users of water in opening and closing gates, etc. The experience of the author indicates that in works where the normal static pressure was

TABLE No. 1.

Internal diam.	Minimum Thickness.	Weight per foot of cylinder.	Weight per foot of pipe laid, including bells.	Weight per length of pipe 12 ft., including bells.	Ultimate strength of 18,000 lb. iron.	One-fifth of the ultimate strength.
4	0.32	13.57	14.67	176	2880	576
6	0.35	21.82	23.83	286	2100	420
8	0.37	30.43	33.00	396	1665	333
10	0.40	40.83	44.33	532	1440	288
12	0.45	55.00	59.83	718	1350	270
14	0.47	66.76	72.75	875	1210	242
16	0.50	80.99	88.42	1061	1125	225
18	0.52	94.54	102.25	1227	1040	208
20	0.55	110.95	117.92	1435	990	198
24	0.60	114.89	156.50	1875	900	180
30	0.70	210.97	227.00	2724	840	168
36	0.80	289.04	310.75	3729	800	160
40	0.85	340.87	369.25	4431	765	153
42	0.90	379.03	410.58	4927	770	154
48	1.00	481.03	521.00	6253	750	150

100 lbs., doubling this, or 200 lbs., was a sufficient allowance. Still there might be cases where even an excess of 100 per cent. above the normal pressure might not meet all the conditions of accident or ignorance, and each engineer must settle this question for himself. After calculating the thickness of the pipe cylinder for certain material and pressures, a safety factor of five, only on larger pipes, is ample according to all the data obtainable from some 500 American and Canadian water-works. It is now perfectly feasible to obtain pipe material having a tensile strength of 18,000 lbs. per sq. in. And with such material used Mr. HOWLAND gives the theoretical table of dimensions, weights, etc.: in Table No 1.

To the objection that a 6 in. pipe only .35 in. thick, is too thin to tap, the author replies that with present tapping machines, and a short plug tap on the corporation cocks, a service connection could be made in a 6 in. pipe even only .3 in. thick. While estimates and calculations show the above figures to be perfectly safe, they are so radically different from custom that Mr. HOWLAND has yielded to this custom and prejudice to the extent of adopting for his own practice the weights, etc. given below.

TABLE No. 2.

Internal diam.	Thickness, inches.	Weight per foot of cylinder.	Weight per foot of pipe, laid, including bells.	Weight per length of pipe to lay 12 ft.	Ultimate strength when made of iron having tensile strength of 18,000 lbs.	One-fifth of the ultimate strength.
4	0.40	17.27	18.75	225	3600	720
6	0.42	26.46	28.92	347	2515	503
8	0.45	37.33	40.50	486	2025	405
10	0.50	51.54	56.17	673	1800	360
12	0.55	67.76	73.75	885	1650	330
14	0.58	83.02	90.67	1088	1491	298
16	0.60	97.78	106.78	1281	1350	270
18	0.64	117.11	126.67	1520	1280	256
20	0.70	142.25	153.43	1841	1260	252
24	0.80	194.77	210.33	2524	1200	240
30	0.90	273.00	285.33	3524	1080	216
36	1.00	363.22	390.50	4686	1000	200
40	1.10	443.82	480.83	5770	990	198
42	1.16	491.49	532.42	6389	995	199
48	1.30	629.16	681.58	8179	975	195

As an external and internal protection against corrosion the Smith method, improved by adding a small percentage of asphaltum, is recommended. But especial care is required to see that the pipes are well and properly coated.

Cement Lined Pipes.—This pipe has its friends and its enemies and much can be said for and against it. In the Eastern States their cheapness was their principal attraction, but they have very generally proved "a delusion and a snare." Mr. HOWLAND sent letters to all known users of this pipe in the United States and Canada, and from a careful study of the replies found the average life of cement lined pipe, as usually made, to be eight years; and that no place, with two exceptions, that had used this pipe for more than eight years recommended them.

The earlier forms of cement lined wrought-iron pipes were composed of a thin shell of sheet-iron, with overlapping riveted edges, supposed to be water-tight in themselves. After riveting, these shells were lined with a thin coat of cement mortar, usually one part sand to one part American hydraulic cement. When the cement was set, this pipe was laid on a bed of mortar in the trench, joined to their neighbors by a wrought-iron band, and the whole exterior surface covered with a coating of mortar; the joint was usually made with neat cement.

The objection to this pipe is that cement mortar thus made is not an impervious material, and water under ordinary pressures is forced through it, and coming in contact with the shell eats out its strength and the pipe is destroyed. The author noticed in examining miles of this pipe that the iron covered by the neat cement at the joints was almost intact while the other portions were practically destroyed. This leads to the conviction that neat cement would make a better pipe, but difficulties of manufacture and handling come in here. The whole efficiency of such pipe depends upon the manipulation of mechanics, and thus there are too many mistakes possible calculated to make the pipe imperfect. It is cheap, rapidly made, and has many adherents at the present time.

Wrought-Iron Coated Pipe.—In the West wrought-iron pipe simply coated with asphaltum has been used for many years and with the best results; chiefly in mining operations but also for water supply. The only objection is cost and loss of head by laps and riveted seams.

Lap-welded wrought-iron pipe have come into use within the last few years, and so far have proved to be worthy of confidence. They are light, easily handled and fitted; are exceptionally strong; not injured by rough usage, settlement of ground, or water hammer; present smooth interiors, are usually in 18 and 20 ft. lengths and have greater carrying capacity than cast-iron pipe of same diameter. The simplest joint seems to be a cast-iron sleeve locking on to rivets in the ends of the pipe and then poured with lead and caulked as in cast-iron pipes.

The only objection is the question of durability, and the liability to have good asphaltum coating abraded in transport. Of chemical processes for protection, the Kalamein has been extensively used with good results when thoroughly done; but in common with all processes used by ignorant workmen on a large scale is liable to imperfections. Mr. HOWLAND has laid 40 miles of pipe doubly treated by the Kalamein process, and afterwards coated with asphaltum. A line of 12-in. pipe so treated and laid in 1883, was recently found as bright and clean inside as when first laid.

The Bower-Barff process is not much used here; but pipes so treated in England have not been satisfactory, numerous rust spots appearing under atmospheric exposure only.

The Wallen process includes a coating of copper, similar to electro-plating, but has a closer adherence and will not peel off. This process has only recently been introduced and has not had the test of time. Mr. HOWLAND believes that wrought-iron pipe treated by some one of these methods, or some other yet to be discovered, will supersede all other kinds of pipe.

Wooden Pipe has advantages and disadvantages; it is bulky; its short lengths and joints are troublesome to maintain. But made of good, soft pine they are unobjectionable from a sanitary point of view, and in certain soils prove very durable, while in others they last but a few years. As now made these pipes are often strengthened by being wound spirally with wire or hoop iron and dipped in hot tar and sanded.

Earthen Ware Pipes.—This is commonly known as vitrified pipe, and is used in a few places for conduit and distribution mains. They have given good results for years, under a static head of 40 ft. where the joints were made with a wrought-iron band filled with brimstone. They are clean and durable and reasonable in cost, but reduce capacity by frequency of joints and irregularity of shape.

Glass pipes of large diameter are predicted by several large glass manufacturers; but a method of casting them successfully and cheaply has yet to be devised. They would certainly form an unobjectionable pipe, and where a large quantity was to be used could be made on the spot.

The New Explosive "Securite."

We have in *Le Genié Civil*, the following description of the new German explosive "Securité," supplementing what we have already said of it: This is a mixture of nitrate of ammonia with binitro or trinitro benzine, or with the binitro or trinitronapthaline. In supposing complete combustion of the two elements mixed, we have:

1st. With the binitrobenzine:

$$C^{12}\,H^6\,(Az\,O^4)^2 + 10\,Az^2\,H^4\,O^8 = \underbrace{12\,C\,O^2}_{12\ vol.} + \underbrace{44\,H\,O}_{44\ vol.} + \underbrace{22\,Az}_{22\ vol.}$$

The explosion gives, theoretically, 78 volumes of simple gas, carbonic acid, watery vapor and azote.

2nd. With binitronapthaline:

$$C^{20}\,H^6\,(Az\,O^4)^2 + 19\,Az^2\,H^4\,O^8 = \underbrace{20\,C\,O^2}_{20\ vol.} + \underbrace{82\,H\,O}_{82\ vol.} + \underbrace{40\,Az}_{40\ vol.}$$

which corresponds to a disengagement of 142 volumes of gas.

3rd. With the trinitronapthaline:

$$2\,C^{20}\,H^5\,(Az\,O^4)^3 + 33\,Az^3\,H^4\,O^8 = \underbrace{40\,CO^2}_{40\ vol.} + \underbrace{142\,HO}_{142\ vol.} + \underbrace{72\,Az}_{72\ vol.}$$

or 254 volumes of carbonic acid gas, watery vapor and azote. But in practice we ought to have a mixture of CO^2, CO, HO and Az; we will have the same nitrous vapors if the combustion is not total.

So that the explosion may be as complete as possible, it is necessary to use a strong capsule of fulminate, one gramme at least.

The nitrate of ammonia furnishes all the elements necessary for the almost total combustion of the

hydrocarburet nitres; and further, the energy developed by the explosion of the mixture is greater by the sum of the energies which would be developed in each of the two elements exploded separately; this is taught by experience. The use of nitrate of ammonia has been long recommended by M. BERTHOLET for the making of explosive mixtures; but unhappily this salt is very hydroscopic, even at the ordinary temperature of 15° C., 100 parts of water dissolving 200 parts. Its use can only become practicable and really advantageous when this grave fault is eliminated.

Its superiority over the nitrates of soda and potash is easily proven. In effect, each of these three salts disengages practically by the same quantities of oxygen and heat, and their respective equivalents are: nitrate of ammonia, 80; nitrate of soda, 85, and nitrate of potash, 101. To produce the same effect, therefore, it would be necessary to use 101 grammes of the nitrate of potash, or 85 of the soda, to 80 grammes of nitrate of ammonia. Then, with equal weights, the nitrate of ammonia gives more gas and heat than soda, and soda more than potash.

It is for the above reasons that the nitrate of ammonia is used in the new explosive mixture. In appearance, this securité is a powder with irregular grains, hard to the touch, of a yellow color, and giving off that odor of bitter almonds peculiar to the nitrates of ammonia. It will neither explode by shock, nor by contact with a burning body: it can be pulverized without danger, and will not freeze. When approached by fire it melts and burns with a yellow flame and a little smoke; this flame goes out when the burning body is removed.

Le Genié Civil says that securité is not new; it was practically invented in 1885, in Sweden, by CARL LAMN, who called it *bellite*. His patent mentions the employment of a nitrate of soda, of potash, of ammonia, or of barytes, with a hydrocarburet nitre, such as binitrobenzine or trinitronapthaline. Mr. LAMN further stated that one could use these hydrocarburet nitres, either singly, or mixed; and also that instead of one only two or even the three nitrates could be mixed together.

To prepare his *bellite*, he reduced the above materials to a powder, and then warmed them by steam to 100° C. Between 50° and 100°, the hydrocarburet nitres melted and enveloped, as with a varnish, the particles of nitrates, and thus more or less protected them against moisture. After it was cool, the mixture was pulverized and pressed into cartridges.

The New Jersey State Survey for 1886.

The last report of State Geologist GEO. H. COOK, states that the geodetic surveys of New Jersey are moving slowly to an end; 12 years have already been consumed and two more will be required to finish them. Work of this character is necessarily slow, but limited appropriations have made it still more so in this case, though the chief part of the money expended is paid by the United States Government. The topographic survey was rapidly advanced last year; and maps of the work over the whole State have been engraved and issued, excepting for a section bordering Delaware Bay, from Wilmington to Port Norris, and another section on the Delaware river from Frenchtown to near Trenton; certain of the maps published in 1882, and covering the vicinity of New York are to be revised; these include maps Nos. 6 and 7.

The four maps yet to be engraved are Nos. 5, 10, 14 and 15. The total area of engraved maps now represents 6,278 sq. miles, 1840 sq. miles having been completed since the close of 1885. The engraving of a small map of the State on a scale of 5 miles per inch is more than half done. The revision of the early maps Nos. 6 and 7 is deemed expedient for the reason that they were not made from original but were largely compiled from local surveys. The utility of more careful work having been proven by the higher standard adopted soon after their appearance. compilation has long been entirely abandoned, and this section will be remapped from original surveys. The compilation cost for field-work but $2.09 per sq. mile, while since 1880, $5.62 per sq. mile has been expended on similar but original work. The complete series of State maps is expected to be ready in 1888.

The report contains a list of official bench-marks and elevations in feet referred to mean sea-level at Sandy Hook. In the common interest all railroad and city engineers are asked to co-operate and refer their levels to the common datum. These bench-marks are grouped by counties and are fully described and located in each case, including those established by the U. S. Coast and Geodetic Survey as well as those fixed by the State Survey. An extended list of tidal observations is also added.

The geological and mining portions of the report are full and valuable; but we must refer our readers to the text for the detail; and the same may be said of the section relating to the value of the marl deposits of the State to the agricultural interests.

The report on water-supply calls renewed attention to the value of the Passaic river water-shed with its 750 sq. miles of area above Little Falls and a daily supply of 400,000,000 galls. of pure water, and suggest the impounding of this volume by properly located storage reservoirs, less than 20 miles from Jersey City and from 200 to 500 ft. above tide. The artesian wells along the seacoast continue to supply a large amount of pure water, and new ones have been bored during the last year at numerous seaside resorts. One of these, on Long Beach, had an 8 in. pipe sunk 318 ft., with the lower 8 ft. in clay, a 6 in. pipe was then sunk 107 ft. further, and about 10 galls. a minute is obtained; this water rises 14 ft. above the surface.

The report closes with a detailed list of the staff engaged in this State Survey and a summary of expenses. From the latter, it would seem that the appropriation of only $8,000 per annum has been sufficient to meet all expenses. The amount expended and appropriated by the United States for a portion of the topographical surveys was, from July 16, 1884, to June 30, 1887, $33,212.98. The expense of the geodetic survey is paid by the U. S. Coast and Geodetic Survey, and the total amount expended on this work since 1875, is $22,629.76.

Machine Drills in Tunnel Driving.

BY ALFRED LORENZ.

Professor of the Technical School in Brünn. Translated from *Wochenschrift des Osterreichischen Ing. und Arch. Vereines*; No. 11, 1887.

In 1613, comparatively soon after the introduction of powder for blasting purposes, MARTIN WEIGEL, a miner of Freiburg, advocated some system of substituting machine for hand labor in drilling; and in 1613 HENNING HULTIMAN, the rector of Ilefeld, suggested to HIERONIMUS VON WITZENDORF a form of drop-drill*.

As usual with most inventions the question of machine drills for rock-work received little attention until the times showed plainly that there was a demand for some advance upon older practice. The railroad construction of the present century, and more particularly the advantages of a tunnel through the Alps, supplied this demand and set inventors at work. MEDAIL, an Italian engineer, proposed in 1802 to pierce Mont Cenis; and while this project doubtless gave the first impulse to the discovery of a machine drill, it was not until 1844 that BRUTON, after repeated trials, gave it as his opinion that any successful drill of this class must be driven by compressed air, which could itself be further used in ventilation. In 1854 BARTLETT invented a drill which resembles, to a certain extent, those now in use, and in 1855 an air-compressor was introduced by COLLADON.

Trials with these machines demonstrated the feasibility of tunnelling Mont Cenis, and not long after this work was authorized by the State of Turin, with SOMMEILLER, GRATTONI and GRAUDIS as the engineers in charge. The results obtained in this first Alpine tunnel encouraged other inventors, until, at the present time, many types are in use, prominent among which may be mentioned the drills of SACHS, DUBOIS and FRANÇOIS, BURLEIGH, MCKEAN, INGERSOLL, TURETTINI and FERROUX.

The above drills, and, in fact, all machine drills made prior to 1876, operated by percussion and were driven by compressed air; but in the year named ALFRED BRANDT, an engineer on the Gothard tunnel, invented an hydraulic machine drill with rotating steel bits.

The constant improvement in machine drilling is best demonstrated by the average daily advance in the headings (working from both ends,) of the three Alpine tunnels, as given below:—

Mont Cenis,	1st year, 1861,	0.48 m.,	last year, 1870,	4.52 m.
Gothard....	" 1873,	3.70 m..	" 1877,	6.00 m.
Arlberg.....	" 1881,	6.54 m..	" 1883,	11.10 m.

This rapid advance can not, however, be wholly charged to the improvement in drills, for the advance in explosives used was equally great, and dynamite was not used at all in the Mont Cenis tunnel.

The machine rock-drills of the present day can be divided into two general groups.

1. Percussion machine drills, with steel bits.
2. Rotary machine drills, with steel or diamond bits. The percussion drill bores a hole with a chisel-shaped bit, which changes its position with each forward stroke. The rotary drills act either with a rapid rotary motion under light pressure, or with a slow motion under heavy pressure, and with drills either of steel or set with carbon points. The Brandt drill acts under heavy pressure with a hollow bit, thus leaving a core. Diamonds, owing to their inability to resist crushing, were found not to be adapted to this service, and a steel drill with curved teeth has been adopted. When working under light pressures, rotary drills can only be used in soft rock; for hard rock, percussion and the Brandt drill alone can be employed.

Compressed-air is the usual motor, though hydraulic power has been used advantageously, as in the Brandt drill. Percussion drills, especially the Ferroux, require about the following working pressures:

In soft rock, minimum,	2 atmospheres.
" hard " "	3 "
" very hard rock "	4 "

The speed of the drill, depending on the pressure, is from 250 to 550 strokes per minute; the drill bores a holes from 1⅜ to 2¼ in. deep per minute in holes from 1⅝ to 2 in. in diameter, and not more than 5 ft. deep in total.

The Brandt rotary drill is operated by hydraulic pressure, as follows:

In soft rock, minimum,	40 to 60 atmospheres.
" hard " "	60 to 90 "
" very hard rock "	90 to 130 "
Maximum pressure	150 "

The revolutions per minute of the bit range from 3 to 8, and the water consumption is from 6 to 8 galls. in the same time. The outside diameter of the bit is from 2.36 to 3.14 in.; and the thickness of the tube is from .35 to .58 in. The progress per minute ranges in depth from 1⅛ to 2¾ in., according to the pressure applied and the hardness of the rock and in holes not over 6½ ft. deep; the holes are from 2½ to 3¼ in. in diameter.

The tests made in the central portion of the Arlberg tunnel between percussion and the rotary Brandt drill were favorable for comparison, as the rock was uniform. The results obtained from Jan. 1, 1883, to Nov. 13, 1883, when the headings met, were as follows:

	East. Percussion.	*West* Rotary.
Working time, days	317	317
" " all delays deducted	304.02	307.08
Total heading driven, feet	5,653.08	5,645.02
Average daily progress, "	18.56	18.37
" length of shift, hours	6.45	6.15
" progress in shift, feet	5.25	4.79
Total holes drilled	35,130	16,490
Average per shift	.33	.14
" depth of holes, feet	5.80	4.72
Total dynamite used, pounds	73,700	70,620
Average dynamite per lin. ft. of heading, pounds	13	12.47
Number of drills used	6	2
" of men drilling	12	5

The above table shows that there is very little difference in the work done by the two classes of drills, and both can be regarded as meritorious. The claim of some parties that the Brandt drill will gradually supersede the percussion is hardly well founded. Its advantages over the percussion drill are—the smaller cost of plant, fewer repairs and steadier and more quiet working. But an impartial examination will disclose certain disadvantages in the rotary drill. These are—the greater shattering of the rock, due to larger holes, the additional amount of water added to what may be found in the rock, and its limited application to different classes of rock.

The greater shattering effect is easily accounted for, when we consider that with the Brandt drill the holes are about 3¼ in. diameter, while with the percussion drill they are only about 1⅞ in. The explo-

*RZIHA, *Eisenbahn Unterbau und Oberbau*; 1876.

sives required for a 3¼ in. hole produce a certain effect, and in order to produce the same effect with $1\frac{3}{16}$ in. holes, 2.14 times as many will be required. According to the theory of EDWARD RZIHA and of HÖFLER it is shown that the combined shattered zones of the 2.14 holes of the smaller diameter lie within that of the larger hole. As actual test is lacking in heading-work, we can only compare the enlargement of the shattered zone, as coupled with an increased diameter of bore-hole, by comparing the number of holes and quantity of explosive used by the two systems.

In the Arlberg tunnel, the charge per hole made by the Brandt drill was double that used for the Ferroux drill-hole, from which we may theoretically reason that the Brandt system shatters the rock more than the other. Hard, massive rock is affected but little outside the lines of prescribed section; but with friable, laminated or stratified rock, this is not so, and excessive blasting-shock may provoke falls of the roof. The accumulation of from 6 to 8 gals. of water per minute from the Brandt drill may, under certain conditions be a serious objection, especially in soft, friable rock. This was shown in the Metzburg tunnel on the East Hungarian Railway which was in an argillaceous slate rock; the combined action of water and air disintegrated this material so rapidly that timber and masonry lining was required, and here the use of a Brandt drill would have aggravated the trouble. The working of this rotary drill in fissured rock has yet to be tested; the core, too, in friable rock would be liable to accumulate in the hollow drill rod and interrupt the drill progress, and in conglomerates, the rotary drill would probably stick fast. The easy, noiseless operation of the Brandt drill is however claimed as a decided advantage and it requires on this account fewer repairs.

A comparison of advantages and disadvantages of the two systems shows that—in isolated cases the Brandt drill is to be preferred; that in certain cases both are equal, but in many cases the percussion drill can be used where the other is hardly practicable. Both will work equally well in granite, syenite, basalt, porphyry, etc. Where water to work the machine is scarce, the Brandt drill is recommended. The cheaper cost of the Brandt drill plant and its maintenance can hardly be taken as an argument in its favor; for if the length of time required for the execution of any important work is taken into consideration, the difference in cost of the two plants is inconsiderable; should the nature of the rock be such as to invite falls, which the use of the Brandt drill would aggravate, the consequent delay in time of completion, and interest on the money invested for this additional period would aggregate a much larger sum.

Corps of Engineers, U. S. A.

Mr. SIMON NEWTON, of the Washington Aqueduct department has compiled a register of the Corps of Engineers, U. S. Army, from its establishment March 16, 1802 to the present date. This little volume shows that there has been a total of 385 officers attached to this corps in the intervening 85 years; including 6 brigadier generals, 29 colonels, 24 lieutenant-colonels and 50 majors. Of this total 109 are now in service; 144 have died; 20 have retired, resigned or been transferred to other branches and are still in service, and 27 have resigned and are now in civil life; all but 16 were graduates of the Military Academy.

The States furnishing the larger number of engineering graduates were—New York, 58; Massachusetts, 34; Pennsylvania, 32; Connecticut, 17 and Ohio, 12; the remainder are scattered all over the United States, but the five States named supplied about 40 per cent of the total.

THE New Croton Aqueduct Commission report $494,604.07 expended in the month of March last on monthly estimates to contractors for work done in February. In the same month the sum of $24,583.12 was paid out in February salaries to engineers and employés, and about $3,000 more for incidental expenses. The liabilities for March, of all kinds, were estimated at $541,141.72.

SOCIETY PROCEEDINGS.

Association of Engineering Societies.

MINUTES OF A MEETING OF THE BOARD OF MANAGERS. PROPOSED CONFEDERATION OF ENGINEERING SOCIETIES.

CHICAGO, ILL., April 15, 1887.

Meeting called to order by the Chairman, BENEZETTE WILLIAMS, at his office, at ten o.clock A. M.

There were present BENEZETTE WILLIAMS and L. E. COOLEY of the Western Society of Engineers, Chicago; W. S. CHAPLIN of the Boston Society of Civil Engineers; C. J. A. MORRIS, of the Civil Engineers' Society of St. Paul; and J. B. JOHNSON of the Engineers' Club of St. Louis.

Secretary PROUT being absent Mr. JOHNSON was elected Secretary *pro tem.* The Chairman stated the objects of the meeting to be, to make a new arrangement for the printing of the Journal; the election of officers of the Board; and the furthering of the original objects of the Association in the matter of a more inclusive, and perhaps a closer union of the several engineering societies of the country.

After a full discussion of these subjects, it was ordered that the proposition submitted by Secretary PROUT, for printing of the journal of the Association, be accepted, provided that the number of surplus copies of each issue, over and above all takers, shall be at least 50 per cent. of the number taken in the Association, and that the remainder of these, on the termination of this contract, shall become the property of the Board of Managers, and provided that the publication shall appear, as heretofore, as published by this Board, and provided that no article shall be allowed to appear in any periodical, before the circulation of the copies of the Journal which contain said article.

The application of the Engineers' Club of Kansas City, to become a member of the Association was granted, thus making seven societies now in the Association.*

Chairman WILLIAMS and Secretary PROUT were unanimously re-elected to their respective offices. It was ordered that the Index Department remain under the general control of Mr. JOHNSON, as heretofore.

Messrs. WILLIAMS, COOLEY, and CHAPLIN were appointed a committee, to draft an address to the societies now in the Association on the subject of forming an organic confederation of Engineering Societies, and to report on the following day. Adjourned.

CHICAGO, April 16, 1887.

Meeting called to order by the Chairman.

The committee appointed to prepare an address to the societies in the Association reported the following:

ADDRESS TO THE SOCIETIES NOW IN THE ASSOCIATION.

"The Association of Engineering Societies was organized some six years ago, its primary purpose being the joint publication of the transactions of the various Engineering Societies of the country. The movement was looked upon with forbodings by many, while others hoped that the habit of coöperation thus inaugurated, would ultimately lead to a broader and closer union, national in its scope. The Association originally comprised the societies and clubs located at Boston, Cleveland, Chicago, and St. Louis, with an aggregate membership of about four hundred. The success attending the Association, and the enviable status of its publication, give abundant promise of permanence and of future growth.

"The Board of Managers has always been disposed to encourage fuller coöperation, believing that there was a growing desire among engineers for a comprehensive organization which should represent them as a whole and as a profession. The efforts recently made in this direction do not seem to be fruitful in results, and we venture to ask that the societies in this Association, and all others interested, consider the advisability of taking steps which may lead to a national organization. If this shall appear desirable it would seem best to appoint delegates, who may meet and discuss the many questions which must be settled before such an organization can be perfected.

"In the absence of any authority which can act as intermediary, the Board offers its services in obtaining the sense of the several societies of the country, and in any other way in which it may aid in this very desirable action. If the societies of the Association favor such a movement of the Board, respectfully suggests that it be empowered to issue a call, and arrange for a convention.

"In order to arrive at a conclusion in a practicable manner, the following specific proposition is submitted for the consideration of the societies in the Association:

PROPOSED ACTION OF SOCIETIES.

"*Article* 1. The (here insert name of society or club) authorizes the Board of Managers of the Association of Engineering Societies, on the favorable action of two-thirds of the societies in the Association, to call a convention of delegates from the several societies of the Association, and such other societies as the Board may invite, said convention to consider the question of an organization of the several societies of the country in a confederation or such other union as may be found desirable. The Board is also empowered to lay before this convention such other matters as it may consider of general moment.

"*Article* 2. The Board of Managers may determine the time and place for such a convention. The representation of each participating society shall be three votes and one additional for each fifty or fraction thereof in excess of one hundred members.

"*Article* 3. The conclusions of this convention shall not be binding upon any participating society until ratified by said society, and when two-thirds of the participating societies have ratified the action of said convention, the proposed organization may go into effect."

The report was adopted and the Chairman was directed to send a copy of it to each of the societies belonging to the Association.

In matters pertaining to the proposed convention of Engineering Societies, the Chairman was authorized to act for the Board.

The Chairman was authorized to address a letter to the Pittsburg, Denver, Pacific Coast and Southern Engineering Societies, inviting them to become members of this Association.

It was ordered that the official documents of the Council of Engineering Societies upon National Public Works be published in the Journal.

The Chairman and Secretary were authorized to levy an assessment on the Association to meet the obligations incurred by the contract for printing and other necessary expenses, including the expenses of this meeting.

Adjourned *sine die*.

J. B. JOHNSON, Sec'y., *pro tem.*

*Three other societies have since joined and the total membership has nearly doubled.

Engineers' Club of St. Louis.—Meeting of April 20 1887. Mr. C. W. CLARK read a paper on "Experiments with Submerged Adjutages," describing some experiments made at the University of Illinois. He deduced the results, giving the coefficient of discharge for each form of adjutage experimented with.

A paper by Col. E. D. MEIER was announced for the next meeting.

The National Bridge Builders' Association held its closing session April 22 at the Lafayette Hotel, Philadelphia.

There were present: WM. SELLERS, of the Edgemoor Iron Co.; DAVID REEVES, of the Phœnix Bridge Co.; Mr. JONES, of Jones & Benner; G. BOUSCAREN, of Cincinnati; H. G. MORSE, of the Morse Bridge Co., of Pittsburg; Messrs. C. C. MORRISON and D. H. MORRISON, of the Columbia Bridge Co., of Cincinnati; H. M. Smith, of the Chicago Bridge Co., and CHAUNCEY ANDREWS, of Boston.

Mr. C. C. MORRISON presided, and Mr. ANDREWS was secretary. A report was made by these gentlemen on the Bussey Bridge disaster, near Boston.

The matter of the Interstate Commerce bill was informally discussed, and the opinion was freely expressed that the railroad companies were taking advantage of it to demand exorbitant rates.

Another question considered was the comparative merit of hot and cold blast in the manufacture of bar iron and steel.

Probably the most important matter, however, that came up, was that of specifications. The car builders of the country some time ago adopted specifications of their own, independent of those of the railroad companies, and these were afterwards adopted by the latter. The bridge builders have already adopted these specifications, and reports showed that contracts based upon them are gradually being accepted by the railroad companies. It was the general opinion that the requirements were too high for the moment of inertia.

AN anecdote is told of United States Judge BOND and his pass, which is enjoyed by the railroad people. The judge on Saturday received the notice requesting the return of his pass. On Sunday he and President GARRETT met on the street about church time. The president asked the judge to turn back and go with him to church. The judge replied, "I am on my way there, but not to your church." "To what place of worship are you going?" asked the president. "To the Synagogue," said the judge. "Why do you go there?" "To turn the passover," answered the judge. The president was lost in thought for a moment, and then continued briskly on his way. Since then it is reported the president has been threatened with a touch of rheumatism.

Drainage Pumps.—M. Knoebiekamp, of East St Louis, Ill., contractor for the draining of Big lake, made a trial of the pumping engines last week in the presence of the Drainage Commissioners; the performance was satisfactory.

Table of Velocity-Heads;

(Referred to on page 286.)

TABLE 118.

TOTAL ENERGY OF POTENTIAL LIFT IN VERTICAL FEET (OR VELOCITY HEAD) IN TRAINS MOVING AT VARIOUS VELOCITIES.

Including the effect of the Relative Energy of the Wheels for Passenger or Loaded Freight Trains, assumed at 6.14 per cent of the total energy. For trains of empty flat or coal cars add about 4 per cent to the quantities below, and proportionately for mixed train

Miles Per Hour. Vel. ft.	0. 0.00	1. 0.04	2. 0.14	3. 0.30	4. 0.57	5. 0.89	6. 1.28	7. 1.74	8. 2.27	9. 2.88
Miles Per Hour.	.04	.1	.2	.3	.4	.5	.6	.7	.8	.9
00	3.91	3.94	3.99	3.77	3.84	3.90	3.99	4.09	4.15	4.29
01	4.30	4.38	4.46	4.54	4.62	4.70	4.79	4.87	4.95	5.03
02	5.11	5.19	5.28	5.37	5.46	5.55	5.64	5.73	5.82	5.91
03	6.00	6.09	6.18	6.27	6.36	6.45	6.54	6.63	6.72	6.81
04	6.96	7.06	7.16	7.27	7.37	7.47	7.57	7.68	7.78	7.89
05	7.99	8.10	8.21	8.32	8.43	8.54	8.65	8.76	8.87	8.98
06	9.09	9.21	9.32	9.44	9.55	9.67	9.79	9.90	10.02	10.14
07	10.26	10.38	10.51	10.64	10.76	10.88	11.01	11.13	11.26	11.38
08	11.51	11.63	11.76	11.90	12.03	12.16	12.29	12.43	12.56	12.70
09	12.83	12.97	13.10	13.24	13.37	13.51	13.65	13.78	13.92	14.06
10	14.20	14.34	14.49	14.64	14.78	14.93	15.08	15.23	15.38	15.52
11	15.67	15.82	15.97	16.13	16.28	16.43	16.58	16.73	16.88	17.04
12	17.19	17.35	17.51	17.67	17.83	17.99	18.15	18.31	18.47	18.63
13	18.79	18.95	19.11	19.27	19.43	19.59	19.75	19.91	20.08	20.24
14	20.40	20.57	20.74	20.90	21.07	21.24	21.41	21.57	21.74	21.91
15	22.08	22.25	22.42	22.59	22.76	22.93	23.10	23.27	23.44	23.62
16	23.79	23.96	24.14	24.31	24.49	24.66	24.84	25.01	25.19	25.36
17	25.54	25.72	25.90	26.08	26.26	26.44	26.62	26.80	26.98	27.16
18	27.34	27.52	27.71	27.89	28.07	28.26	28.44	28.63	28.81	29.00
19	29.18	29.37	29.56	29.74	29.93	30.12	30.31	30.50	30.69	30.88
20	31.07	31.26	31.45	31.64	31.83	32.03	32.22	32.41	32.61	32.80
21	32.99	33.19	33.38	33.58	33.77	33.97	34.17	34.36	34.56	34.76
22	34.96	35.15	35.35	35.55	35.75	35.95	36.15	36.35	36.55	36.75
23	36.95	37.15	37.36	37.56	37.76	37.97	38.17	38.37	38.58	38.78
24	38.99	39.19	39.40	39.60	39.81	40.02	40.23	40.43	40.64	40.85
25	41.06	41.27	41.48	41.69	41.90	42.11	42.32	42.53	42.74	42.95
26	43.16	43.37	43.58	43.79	44.00	44.22	44.43	44.65	44.86	45.07
27	45.29	45.50	45.72	45.94	46.15	46.37	46.59	46.80	47.02	47.24
28	47.46	47.68	47.90	48.12	48.34	48.56	48.78	49.00	49.22	49.44
29	49.66	49.88	50.11	50.33	50.55	50.77	51.00	51.22	51.45	51.67
30	51.90	52.12	52.35	52.58	52.80	53.03	53.26	53.48	53.71	53.94
31	54.17	54.40	54.63	54.86	55.09	55.32	55.55	55.78	56.01	56.24
32	56.47	56.70	56.93	57.16	57.39	57.63	57.86	58.09	58.32	58.56
33	58.79	59.03	59.27	59.50	59.74	59.98	60.21	60.45	60.69	60.93
34	61.17	61.41	61.65	61.89	62.13	62.37	62.61	62.85	63.09	63.33
35	63.57	63.81	64.05	64.29	64.53	64.77	65.02	65.26	65.50	65.75
36	65.99	66.23	66.48	66.72	66.97	67.21	67.46	67.70	67.95	68.20
37	68.44	68.69	68.93	69.18	69.43	69.68	69.93	70.17	70.42	70.67
38	70.92	71.17	71.42	71.67	71.92	72.17	72.42	72.67	72.92	73.17
39	73.42	73.67	73.93	74.18	74.43	74.69	74.94	75.19	75.45	75.70
40	75.96	76.21	76.47	76.72	76.98	77.24	77.49	77.75	78.01	78.27
41	78.52	78.78	79.04	79.30	79.56	79.82	80.08	80.34	80.60	80.86
42	81.12	81.38	81.64	81.90	82.16	82.43	82.69	82.95	83.22	83.48
43	83.74	84.01	84.27	84.54	84.80	85.07	85.33	85.60	85.86	86.13
Diffs.	2.58	2.59	2.71	2.64	2.64	2.64	2.64	2.65	2.64	2.65
44	86.39	86.66	86.93	87.20	87.47	87.74	88.01	88.28	88.55	88.82
45	89.09	89.36	89.63	89.90	90.17	90.44	90.72	90.99	91.26	91.54
46	91.81	92.08	92.36	92.63	92.91	93.18	93.46	93.73	94.01	94.28
47	94.56	94.84	95.11	95.39	95.67	95.95	96.22	96.50	96.78	97.06
48	97.34	97.62	97.90	98.18	98.46	98.74	99.02	99.30	99.58	99.86
49	100.14	100.42	100.71	100.99	101.27	101.56	101.84	102.13	102.41	102.70
50	102.98	103.27	103.55	103.84	104.13	104.41	104.70	104.99	105.28	105.56
Diffs.	2.89	2.87	2.73	2.93	2.93	2.93	2.93	2.93	2.93	2.93
51	105.85	106.14	106.43	106.72	107.01	107.30	107.59	107.88	108.17	108.46
52	108.75	109.04	109.33	109.63	109.92	110.21	110.51	110.80	111.09	111.39
53	111.68	111.98	112.27	112.57	112.86	113.16	113.46	113.75	114.05	114.35
54	114.64	114.94	115.24	115.54	115.84	116.14	116.44	116.74	117.04	117.34
55	117.64	117.94	118.24	118.54	118.84	119.15	119.45	119.75	120.05	120.36
56	120.66	120.96	121.27	121.57	121.88	122.18	122.49	122.79	123.10	123.40
57	123.71	124.02	124.32	124.63	124.94	125.25	125.56	125.86	126.17	126.48
58	126.79	127.10	127.41	127.72	128.03	128.34	128.65	128.96	129.27	129.58
59	129.89	130.20	130.52	130.83	131.14	131.46	131.77	132.08	132.40	132.71
60	133.03	133.34	133.66	133.97	134.29	134.61	134.92	135.24	135.56	135.87
Diffs.	3.00	3.00	3.13	3.00	3.00	3.00	3.00	3.00	3.00	3.00
61	136.19	136.51	136.83	137.14	137.46	137.78	138.10	138.42	138.74	139.06
62	139.38	139.70	140.02	140.34	140.66	140.98	141.30	141.62	141.94	142.26
63	142.58	142.90	143.23	143.55	143.87	144.20	144.52	144.84	145.17	145.49
64	145.82	146.14	146.47	146.79	147.12	147.44	147.77	148.09	148.42	148.74
65	149.07	149.40	149.73	150.05	150.38	150.71	151.04	151.36	151.69	152.02
66	152.35	152.68	153.01	153.34	153.67	154.00	154.33	154.66	154.99	155.32
67	155.65	155.98	156.31	156.64	156.97	157.30	157.63	157.96	158.29	158.62
68	158.95	159.28	159.61	159.94	160.27	160.60	160.93	161.26	161.59	161.92
69	162.25	162.58	162.91	163.24	163.57	163.90	164.23	164.56	164.89	165.22
Diffs.	3.19	3.19	3.21	3.19	3.19	3.19	3.19	3.19	3.19	3.19
70	165.55	165.88	166.21	166.54	166.87	167.20	167.53	167.86	168.19	168.52
Diffs.	3.00	3.00	3.13	3.00	3.00	3.00	3.00	3.00	3.00	3.00

Formula (*Vel. head* = $\frac{v^2 \text{ in ft. per sec.}}{64.32} = \frac{1.467^2 V^2 \text{ (in miles per hour)}}{64.32} = 0.033443 V^2$)

To which add 6.14 per cent for rotative energy of the wheels = $0.033443 V^2 \times 0.0614 = 0.035525 V^2$

Giving as the final formula, by which the table is computed, *Vel. head* = $0.035500 V^2$.

The above table is exact for the even miles. The heights for tenths of a mile per hour were filled in by interpolation, and the last digit may be in error.

The process of computing the result of a brake-test by the aid of this table, which may be useful for reference in connection with it, is as follows:

PERSONAL.

Mr. ANDREW CARNEGIE was married last week to Miss WHITFIELD, of New York City.

G. BOUSCAREN has resigned his position as Chief Engineer of the Huntington bridge, across the Ohio river.

Mr. GARTNER has been appointed City Engineer of Lincoln, Neb.

GEORGE K. REEDER has been reappointed City Engineer of Helena, Mont.

A. A. ROBINSON has been appointed Chief Engineer of the Southern Kansas R. R., of Texas, with headquarters at Forth Worth, Tex.

M. J. DRUMMOND, manufacturer of cast-iron gas and water pipe, has removed his office from 95 Liberty street, to the Equitable Building, 120 Broadway (Rooms 17-18), New York City.

THE PASSAIC ROLLING MILL CO. has removed its New York office from Room 45, Astor House, to 45 Broadway (Rooms 151-152).

JOHNSON & WILSON, Agents for Saylor's Portland Cement, will remove their office from 91 Liberty street, to Aldrich court, 41, 43 and 45 Broadway, 17, 19, 21 Trinity place, New York City.

Mr. GEORGE EVANS, City Engineer of Lowell, Mass., has been superseded in office by his former assistant, Mr. GEORGE BOWERS. Politics did it, says the *Morning Mail*, of Lowell.

The following officers have been elected by the Poughkeepsie Bridge Co., New York: President, W. W. GIBBS; Vice-President, W. VAN BENTHUYSEN; Secretary and Treasurer, W. R. CARLILE; Chief Engineer, P. P. DICKINSON.

THOMAS J. POTTER, First Vice President of the Chicago, Burlington & Quincy R. R. Co., has resigned to accept the appointment of First Vice President of the Union Pacific R. R. and Oregon Railway & Navigation companies. His headquarters will be at Omaha, Neb.

M. W. CONKLING, of the Missouri, Kansas & Southwestern R. R., 80 Wall street, New York City, is the man for contractors to interview. He wants to let 100 miles of railroad construction, with the option of letting 1,000 miles to the same contractor. Only men of extensive means and experience need apply.

COL. W. P. CRAIGHILL, U. S. Engineers, according to Washington rumors, will be the next Superintendent of the Military Academy; if he does not see fit to accept, COL. JOHN G. PARKE will stand the next chance. In either event the Corps of Engineers will furnish the new Superintendent.

THE WOODMAN & TIERNAN PRINTING CO., 309 N. 3rd street, St. Louis, Mo., announce that all extra copies of lithographs of the Lachine Bridge, at Montreal, have been placed in their hands for sale, the proceeds of which (after expenses are paid) are to be presented to Mrs. C. SHALER SMITH by Mr. F. D. MOORE. Price for single copies, $2.25, while a liberal discount will be made if ordered in quantity.

W. E. CHAMBERLAIN, of the Boston & Albany R. R., has been appointed Superintendent of the Harlem River branch of the New York, New Haven & Hartford R. R.; E. G. ALLEN, of the New York & New England R. R., has been appointed Superintendent of the Shore Line division, and W. A. WATERBURY, who has been Superintendent of the Shore Line and Air Line divisions of the New Haven road, will assume charge of the Air Line division.

Mr. C. D. JAMESON, Civil Engineer, is confined to his bed in Roosevelt Hospital, at 59th street, this city. Mr. JAMESON was engaged in railroad construction on the Mexican Central R. R.: subsequently while engaged in professional work on the Isthmus of Panama, he contracted the Chagres fever: returning home he was engaged in teaching at the Mass. Inst. of Technology, in Boston, but since last Christmas has been confined to his bed by the fever and only a few days ago returned from a six weeks stay in Nassau, whither he had gone in hopes of regaining his health.

JOHN E. PARKE, one of the oldest of American railroad contractors, died at Downingtown, Penna., on April 10. Mr. PARKE was born March 5, 1808 in the town in which he died. He was a contractor on the old Columbia & Phila. R. R. and there forming the acquaintance of the late J. EDGAR THOMSON; he followed this engineer to Georgia in 1833, and was prominently engaged in railroad building in that section, remaining there until about 1858. About the latter date he retired from active business with a considerable fortune. He was a leading member of the Orthodox Society of Friends.

Mr. HORATIO G. BROOKS, President of the Brooks Locomotive Works, died at Dunkirk, N. Y., on April 20. He was born in Portsmouth, N. H., Oct. 30, 1828; after serving an apprenticeship with SETH ADAMS and in the shops of the Boston & Maine R. R., he became a locomotive engineer; in 1856, master mechanic of the Ohio & Mississippi R. R., and from 1860 held the same position in the Dunkirk shops of the Erie R. R. In 1862 he was superintendent of the western division of the Erie; in 1865 superintendent of motive power and machinery for the whole road; on Nov. 13, 1869, he organized the Brooks Locomotive Works.

HORACE G. HOLDEN, Superintendent of Water-Works, Lowell, Mass., resigns that office on May 2. Mr. HOLDEN has held the office for eight years and is one of the best known and most intelligent water-works superintendents in New England. Previous to his taking office in Lowell he was engaged for twelve years in the construction of water-works and sewers, and on account of his score of years experience as constructor and manager, Mr. HOLDEN is a valuable man for any water-works company to secure in its service. Among his references are Mr. JAS. B. FRANCIS, the celebrated hydraulic engineer, and past President of the American Society of Civil Engineers, and also any of the past members of the Lowell Water Board.

IN our issue of April 16, in noting a paper read by WM. D. JENKINS, C. E., before the Engineers' Club of Kansas City on the Randolph bridge, as reported in a Western paper, the depth of foundation and maximum span were improperly given: those quoted were referred to by Mr. JENKINS simply as possible maximum examples, and did not refer to his bridge. In the Randolph bridge, now being constructed by the Chicago, Milwaukee & St. Paul R.R. Co. over the Missouri river, near Kansas City, the greatest depth of foundation will be 80 ft. and the maximum span will be 400 ft. c. to c. end pins. The total length of the bridge and approaches will be 7342 ft.; 2970 ft. being iron spans and viaduct, the remainder trestle work and piles. Three piers, Nos. 2, 3 and 4, will be founded on pneumatic caissons surmounted by cribs and open caissons.

A ROCK slide occurred April 14, on the Colorado Midland R. R. grade in a deep cut near Buena Vista, on the contract of Messrs. KYNER, HIGBEE & BERNARD. Several men were killed and injured, and Mr Bernard was badly hurt.

Suburban Rapid Transit Railway; Annexed District, New York City.

(*See Illustration Page* 283.)

We present this week plans for the superstructure of the Third Avenue line of the Suburban Rapid Transit Co.'s system of lines north of the Harlem river. Mr. J. J. R. CROES is the Chief Engineer but the designs for this portion of the work have been prepared by Mr. THEODORE COOPER, Consulting Engineer for the company. Erection is so far advanced that the line will be in operation in a few weeks.

The superstructure is designed for three tracks, but for the present the middle track is omitted, except where needed for turnouts; it is proportioned to carry 30-ton locomotives. The posts are placed 23 ft. apart c. to c., spanning the existing surface railroad tracks, and the general details are clearly shown in the plans presented.

The cast pedestals raise the wrought-iron work above the surface of the street paving, so that it may be least effected by surface water and readily accessible for inspection and painting. The posts themselves are formed of channels, latticed; the flanges of the channels being turned in so as to reduce the amount of obstruction in the street.

All the girders are plate girders, which not only supply the most economical construction for equivalent strength, but also avoid the slovenly appearance so common in lattice girders, with their many recesses for the deposit of moisture, dirt, bird's nests, etc., and the resulting rust and decay. Plate girders, moreover, give a reassuring sense of greater safety; for while in a lattice girder of such moderate span, the maximum strength and security must depend upon the perfection of two to five rivets in any one vital connection where one or more defective rivets may reduce the security from 20 to 50 per cent.; in a plate girder, numerous defective rivets, the grossest neglect and the worst of workmanship would be necessary to produce any such equivalent reduction of security.

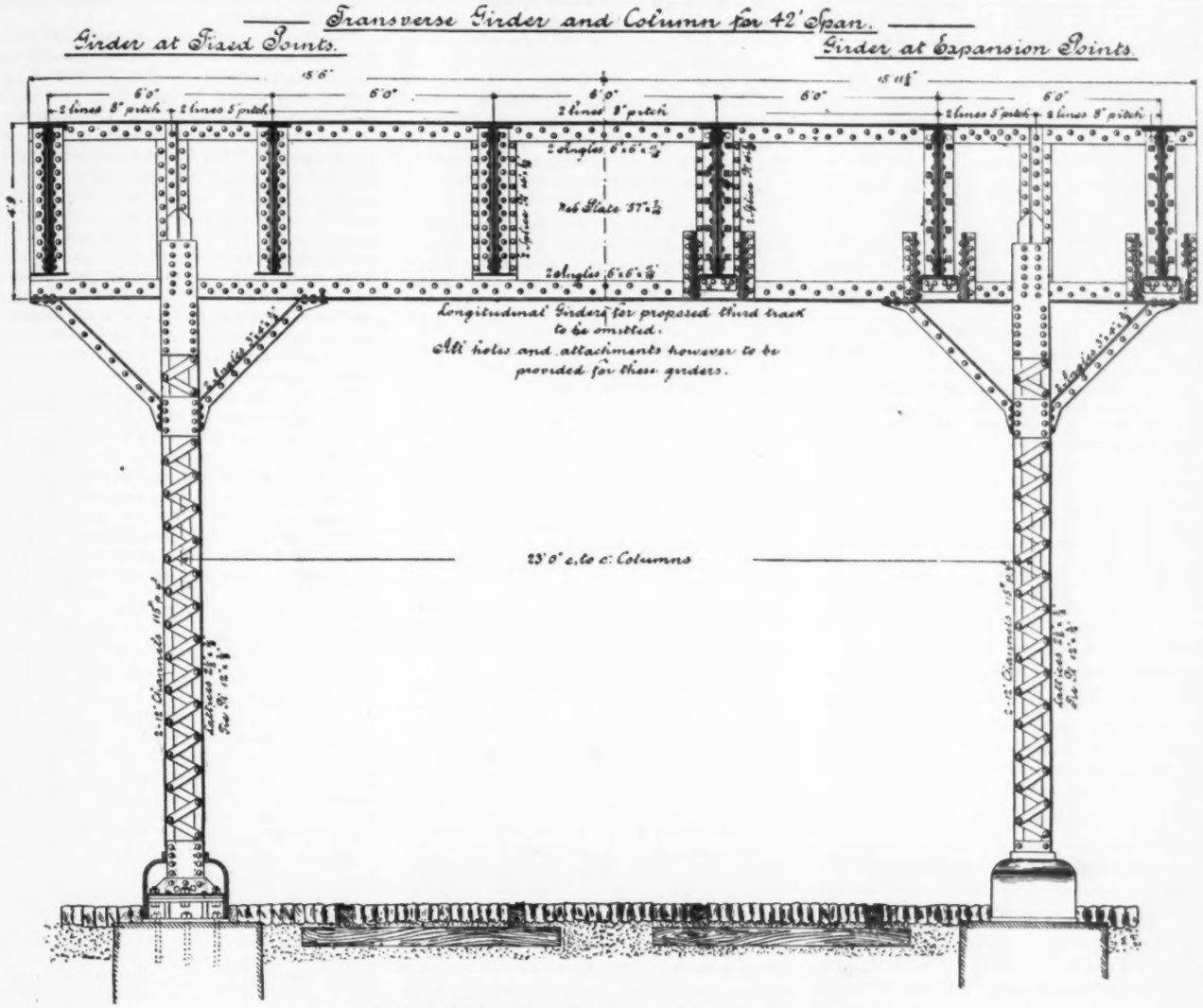
It will be noticed that the posts were not anchored down through the masonry as usual. Mr. COOPER has here introduced a method of securing longitudinal and transverse stiffness radically different from common practice, and this method was first adopted by him in his design for the Pittsburg Junction Elevated R. R., through 33rd street in that city. Instead of anchoring heavy castings to the foundation masonry and then inserting and rust-jointing the posts to these castings, he secures his post rigidly to the girder work above, or anchors his post at the *top* instead of at the bottom.

If a four-legged table be inverted, the four legs extending into the air will represent the ordinary practice of anchoring the posts at the bottom. If upon the ends of these legs models of longitudinal and transverse girders be placed, it will readily be conceived how the anchorage at the bottom resists the overturning tendency of rapidly moving trains subject to quick stoppages by the air-brakes. But if we now return the table to its proper position, resting on its feet, and the rigidly attached framework at its top be taken to represent the system of transverse and longitudinal girders, it will readily be seen that the anchorage of the legs at the top must now act exactly as before to prevent overturning. This is the general principle adopted by Mr. COOPER for stiffening his structures of this character.

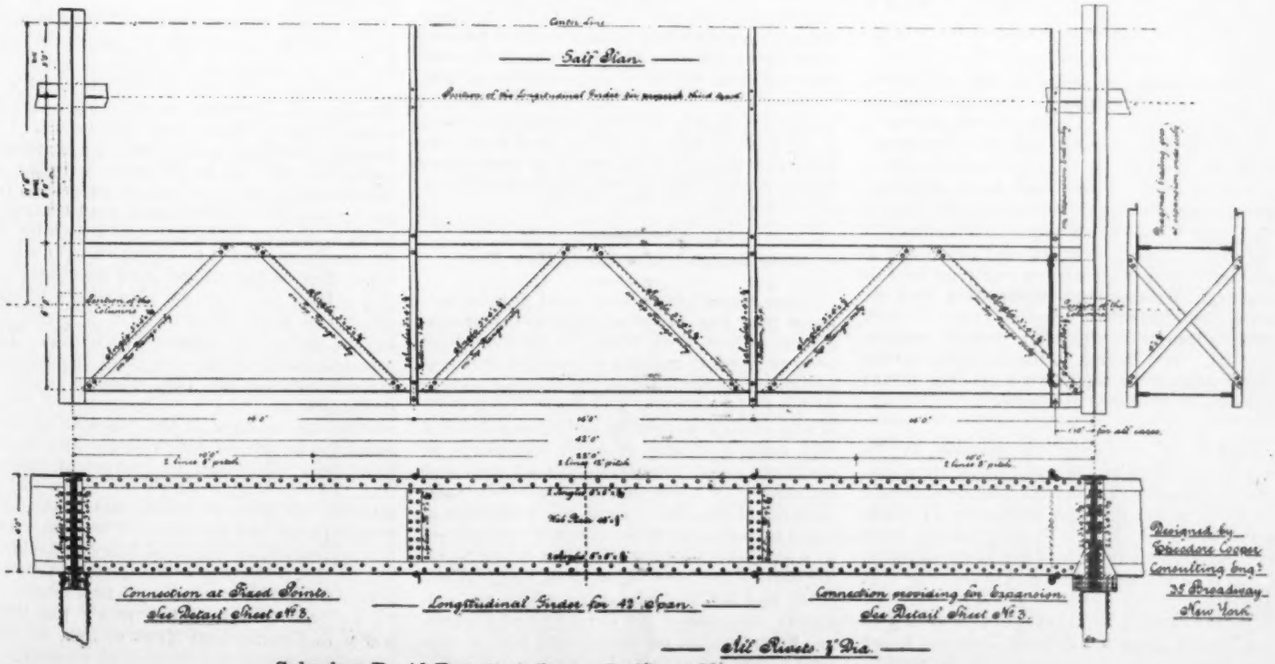
The expense and trouble of inserting the long anchor-bolts into the foundation and the ancient method of leveling up and securing these posts by the use of lead, sulphur or iron-rust, is avoided. The cost of the foundation is thus materially cheapened; the erection facilitated and more accurate results obtained; and all without loss of the desired stiffness.

A visit to the structure and a comparison with various existing types of elevated railroads in this vicinity will impress even the non-professional inspector with the idea that that, even in combining such apparently simple elements as girders and posts, the Suburban Co. has done well in retaining as an advisor an engineer who is thoroughly posted in all that has been done in this direction and yet seeks out better and more economical results.

ACCORDING to *Science* the geographical center of the United States, Alaska excluded, is to be found in Cora township, Smith Co., Kansas; or in latitude 39.8° N., and longitude 98.8° W. of Greenwich.


Transverse Girder and Column for 42' Span.
Girder at Fixed Points.
Girder at Expansion Points
Longitudinal Girders for proposed third track to be omitted.
All holes and attachments however to be provided for these girders.
23'0" c. to c. Columns

Suburban Rapid Transit Railway; Transverse Elevation.



Suburban Rapid Transit Railway; Longitudinal Elevation and Half-plan.

ENGINEERING NEWS

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D. McN. STAUFFER. A. M. WELLINGTON, EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year*; $2.50 *for Six Months*; $1.50 *for Three Months*; *Single Copies*, 12 *cents*. FOREIGN COUNTRIES, $6.56 *per Year*, or 3 *cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also,* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

THE first subscription in response to Mr. DORSEY'S offer which we printed in our last issue, came from Mr. ECKLEY B. COXE, at which those who know Mr. COXE will not be surprised. We regret that no further subscriptions have been received in time for acknowledgment in this issue, but the time has been rather short, and as at least twenty subscriptions are required to make those which have been made binding, we shall hope to receive a number in time for acknowledgment in our next issue. Three of these twenty subscriptions only have yet been received. Mr. DORSEY'S offer, we may remind our readers who did not chance to see his letter in our last issue, was to be one of twenty to subscribe $100 each to a fund to be devoted exclusively to the purchase of books to supply the more urgent deficiencies of the library of the American Society of Civil Engineers, and thus make a start toward making it what it should be, THE technical library of the country.

A CORRESPONDENT sends us an inquiry in respects to the merits of a certain "patent axle-box." There is plenty of room for a "patent axle-box" which shall be an improvement on those now in most general use, which are wasteful of oil and come far from giving the best of lubrication, but the specific one he mentions is unknown to us, and we suspect (although we may be wrong in this) is not in use *as an adopted device* on any road in this country. Without more information than the name, we cannot express a more decided opinion than this, which is a merely cautionary one. The device alluded to may be the coming thing for aught we know, but it has not come yet, to any large extent.

Boston is evidently unfortunate in its official handling of the water-meter question, and unless some very radical changes are made in the peculiar methods seemingly in vogue there, it will continue to be unfortunate. After the disgraceful exposure of the Tremont meter fraud it would be but natural to suppose that a decent amount of caution would be exercised by official meter-promoters; but according to the Boston press the defunct Tremont meter has already a worthy successor in the Star.

This latter is a meter nominally invented by the present Superintendent of the Water-meter Division, but is actually an acknowledged infringement on an English patent. As this meter is to be entered in the pending official trial of meters, to which all reputable makers of meters are invited to send their products, and as this trial is to be virtually conducted by this Superintendent-inventor and his backers, it is just possible that this particular Star will outshine all the rest—in the final report.

The whole history of the late introduction of the meter-system into Boston is interesting and instructive reading. The Water Board pointed to the experience in Providence, Fall River and Pawtucket for proof of the great good to be derived from such adoption and the "economy" that was to result to their own city. Providence has 55 per cent. of its water supply now measured by 7300 meters, and employs a force of *three men* in taking care of them at an annual expense of about $4000, which sum is actually returned in the form of work done for meter-users, so that the department is self-sustaining. Pawtucket has 1896 meters, cared for by *two men* at an annual expense of $2000; and Fall River has 2755 meters which *one man* looks after without undue exertion. This Rhode Island record is undoubtedly very good, and the resulting saving in water supplied and the money represented thereby was effectively used to bait the Tremont meter-hook by which the good citizens of Boston were caught about four years ago.

But in adopting the meter system the Boston Water Board somehow missed the sober honesty and economy which characterized the Rhode Island admistration of this department. On Jan. 1, 1887, 3891 meters of all types were in use, in Boston: but to take care of these meters places were found for *twenty-four men*, and the sum of about $35,000 was expended in one year. Quite a contrast, in men and money, to the Rhode Island cities named; and this contrast is more striking when we notice in the Boston Auditor's reports that previous to 1883 and under Superintendent Jones, three men cared for 2000 meters at an expense of about $5000 annually, including all expenditures. The auditor's accounts further show that in 1883-84, the bill for recording meters suddenly jumped to $13,000 and in 1884-85, to $38,000: this was exclusive of special appropriations for new meters and in the last named period $75,000, out of a total of $86,000, went to the Tremont meter people. But in 1885 the city spent $55,000 in managing about 4800 meters; 2500 meters less than Providence handles with four men and practically no expense at all to the city. Verily, may we repeat with the Boston press, there is very grave reason for overhauling this department from top to bottom.

State Bridge Inspection in New York.

It has already been mentioned in these columns that the Board of Railroad Commissioners of New York State has for some time been engaged in making a thorough and systematic examination of all the railroad bridges within its jurisdiction. The report of this work is now nearing completion and when published will make a volume of some 1200 pages of doubtless much interest to railroad men and engineers. While we are not prepared to take the ground that the system below outlined is in all respects just what should be established as a permanent institution, since it in a measure carries the false implication that it is the State and not the companies which are primarily responsible for the safety of bridges, yet there can be no doubt that just at this time and as a beginning the steps taken could hardly have been improved upon, and well deserve to be widely copied.

Within a year after the organization of the Railroad Commission in 1883, three bridge accidents happened on roads in the State, all attended with loss of life and more or less discredit to the railroad officials. The occurrence of these accidents within so short a time led the Board to believe that the public safety demanded a thorough and systematic examination of all the railroad bridges in the State and this immense work was an once begun by requiring the roads to file with the Board a plan and strain sheet of every truss bridge on their lines, and by employing an engineer whose sole duty it has been to examine the plans critically, to check the strains in all members and when necessary to visit and examine on the ground any structure which might seem to need more minute inspection.

The process adopted by the Board is as follows: As soon as a bridge plan is received it is subjected to a preliminary examination to detect any obvious defects of construction which exist, and it is then laid aside until all the bridge plans of that road are received. As soon as possible thereafter these plans are taken up in order, minutely examined and the stresses in all members of each structure completed, using as nearly as can be ascertained the actual moving loads which are customary on each particular road. Whenever defects are found they are at once reported to the railroad company with the recommendation that they be remedied. An opportunity, however, is always afforded the road for a hearing, should the company consider the Board's recommendation uncalled for. So far, it may be mentioned, every recommendation of the kind has been promptly complied with. The Board also requires that a plan and strain sheet of every new railroad bridge erected in the State be filed as soon as the structure is completed. A record of every bridge in the State is thus kept at Albany.

It will be seen that the method adopted by the Board insures the separate inspection of plans, and computation of stresses by at least two different persons, one employed by the State, and the other by the railroad. Any errors of computation, or objectionable modes of construction are thus pretty likely to be discovered, and if serious they are required to be corrected.

But all this work would avail but little, were not provision also made to insure that the bridges be kept in good physical condition.

The Board does this through its Inspector, Mr. THOS. W. SPENCER, an engineer and railroad builder of many years experience. The Inspector's duty is to go slowly and carefully over every railroad in the State as often as circumstances will permit, to ascertain the general condition of the track, road-bed, right of way, station buildings and especially all the openings crossed by the track. This field inspection of the bridges, and the office scrutiny of their plans are supplementary to each other, and both together form a pretty effectual safeguard against accidents. The practical benefit of this system of inspection is evident from the fact that whereas during a single year previous to its inauguration, three failures are recorded in the State, all of them being due to defects which might and should have been discovered by competent inspection, the only bridge which has since fallen, was one, the truss of which was struck by a derailed train and knocked off its seat. And it is interesting to note that this last accident led to the perfection of the CHILDS—LATIMER bridge guard, undoubtedly the best device for its purpose ever invented, which was illustrated in ENGINEERING NEWS of Feb. 26, 1887, immediately after the Woodstock disaster.

The report of the Board on this bridge inspection will contain a brief description of every truss bridge in the State, an outline diagram showing the general style and dimensions of the truss, and a tabular statement of the stress in each member, the composition of the member in detail, the sectional area and the strain per square inch. The dimensions of floor-beams and stringers also are given, the date of erection, and points of particular interest which may attach to the structure. Whenever any changes have been recommended, a full statement of each case is given with the reasons for making the recommendation, and the action of the railroad company in the premises.

The amount of strengthening of bridges which this work of the Board has caused will by no means be all shown in the report, for on many railroads the bridges were all carefully examined, many reinforced and not a few entirely rebuilt before any plans were submitted in order to forestall the publicity which would otherwise have been given to the fact that such and such bridges had been found weak and required strengthening.

The most common weakness which has been found is in the tension rods of Howe truss bridges, many of which are scant in section. Most of the older structures of this kind and some even of recent date were built according to the time-honored "rule of thumb" process and have consequently required a good deal of strengthening to make them safe for modern traffic. As a rule railroad officials are glad to have such defects pointed out to them and are only too willing to correct them promptly and in the best manner. But occasionally it is otherwise. A certain railroad which carries some 300,000 passengers a year, had along its line quite a number of Howe truss bridges which were not up to the standard, in consequence mainly of light tension rods. The president of the road is the Grand Mogul of his company and autocrat of all things pertaining thereto. He does not believe in engineers, but employs as bridge superintendent an old bridge carpenter whose life has been spent in the business, and who probably does know all about a Howe truss bridge except how to design one properly. On being requested to reinforce certain tension rods which were strained from 20,000 to 25,000 lbs. per sq.in. this sapient president demurred, arguing that under this strain no sort of alarm need be felt, that good iron was not expected to break under 60,000 lbs. per sq. in., that the rods in his bridges were of good iron, and that *therefore* there need be no apprehension whatever until 30,000 lbs. per sq. in. was reached, which would still have an ample margin for emergencies. And he was fortified in his opinion by his bridge superintendent. The greatest danger from weak bridges is not likely to be found on a road which confessedly has no officer who knows anything about them, for such a road generally calls in some competent expert and gives its bridges an intelligent overhauling, occasionally at least. But when we come to a road which keeps a bridge superintendent whose boast is that he is a practical bridge carpenter and has followed the business for forty years or more, then we may well look out for danger ahead.

While New York does not possess any of the wonders of the bridge builder's skill except the Brooklyn bridge and the Niagara cantilever, which lies partly within the State's bounds, still it contains a great many examples of interest to the engineer and student. The new Poughkeepsie bridge will, when finished, exhibit spans rivalling the longest in the world. We do not remember any double track span in America which equals that on the West Shore railroad near Fort Montgomery, which is 290 ft. in length. The same road possesses at Syracuse a lift bridge which is without a parallel. It is a double track structure, 95 ft. long and weighing 110 tons, and the whole bridge is lifted bodily about 10 ft. every time a boat passes. The Stony Brook viaduct, 225 ft. high, on the Lackawanna & Pittsburg railroad, though not as lofty as the Kinzua viaduct, is high enough for most people. This State is the field in which SQUIRE WHIPPLE first showed the fruits of that genius to which every bridge engineer in America is indebted. On the Utica & Black River road some of his earliest iron bridges are still in daily use without change, and without more than ordinary repairs since they were first erected, about 1854. The Ogdensburg & Lake Champlain Railroad still has in use a number of old Burr truss bridges dating back to the building of the road in 1848-9. The care exercised in the selection of the material and in the maintenance of these bridges is shown in the fact that they are still as bright and sound as if newly built. Owing to the circumstance that they were designed for a double track, while only a single track has been laid, these bridges safely sustain with little, and, in some cases, no strengthening, loads which are more than double those in use at the time they were built.

The New York Commission is the first one that has ever attempted bridge inspection on so large a scale. The Ohio Commissioners maintained for some years a system of field inspection and published a pretty full report of the same, with the sizes of the principal members in most of the bridges. Other commissions have made spasmodic efforts in the same direction or have investigated a bridge here and there which they had reason to think might be weak, but no public body has heretofore undertaken to get and record the exact size of and strain in every member of every bridge in the state. In this and in other ways they have shown an enlightened zeal which does honor to the State and to themselves.

The Second Contributing Cause to the Bussey Bridge Disaster.

Every one remembers the nursery story of the man who was not hurt at all by a fall from a window, but only by the sudden bringing up. In the same way the Bussey bridge disaster lay, not in the fall of the bridge, it is important to remember, but in the consequences which followed the fall of the bridge. In neither case is the distinction a mere quibble. If falling from windows was a constant danger to mankind, and accredited means existed, in almost universal use, by which a man might always have a cushion about him to ease his fall, and a man were to have such a fall, and from absence of the usual cushion were to be killed, we should justly say that his death was primarily chargeable, not to his fall, but to his negligence.

In the same way, the Bussey bridge disaster, speaking of it in its true sense, as the slaughter and wreckage which followed the breaking down of the bridge, was primarily rather than secondarily due to the defects of the rolling stock equipment and not of the bridge in that the train was not provided with the accredited and almost universally used type of passenger brake, the automatic, but only with the inferior and far less safe "straight-air" type which began to go out of date two years before the Bussey bridge was built, or thirteen years ago, and has been for many years the rare exception.

We present below and elsewhere in this issue evidence which is as conclusive as it well could be—that this was the chief cause for the disaster proper, and that except for it, the mere fall of the bridge, if indeed it would have fallen at all, which is doubtful—might have done comparatively little harm. That we only do this seven weeks after the disaster is mortifying, but we had not heard before that the brakes were merely straight air. As it is, we believe we are the first to discuss or even mention the brakes as a contributing cause to the disaster, for not a word of comment in relation to it, nor even a bare statement of the fact, has appeared to our knowledge in any of the Boston papers or in the technical and semi-technical press. The matter was first brought to our attention—about ten days since—by a Boston correspondent who was a passenger on the train. The whole testimony in relation to it which we have been able to discover as taken at the official hearing is reproduced elsewhere. A photograph of the bottom of the rear car, the smoker which turned bottom upward, has been in our possession from the first and is reproduced in Fig., 1 but this seemed to indicate that the automatic brake was in use, and the auxiliary reservoir under each car which is its most prominent characteristic had been knocked off in its fall. This however proves not to have been the case.

The important facts, putting them as briefly as possible, are these:

The original "straight air brake was first brought out on the Pennsylvania Railroad in 1869; its use began to become general in 1872; the automatic improvement was brought out in 1874, and by 1876 its introduction had become so general that it was already more than half the business of the company. This was eleven years ago. At the present time something less than 5 per cent. of the Westinghouse brakes in use are straight-air; the rest all automatic. The chief distinction between the automatic and straight-air, we need hardly say, is that if the train parts at any point, the automatic instantly applies the brakes with full force on both ends of the train, while the straight air can only be applied by the will of the engineer, and if the train breaks in two, becomes useless. A train moving at less than 20 miles per hour is readily brought to a stop by it in a distance of 125 to 150 ft., as has happened in repeated instances.

The facts in regard to events in the disaster are these (see testimony of engineer WHITE given elsewhere):

The train was moving at a speed between 15 and 20 miles an hour, but possibly as fast as 25 miles an hour. The engine parted from the train at, or very near to the instant that it passed from the abutment to the solid ground, so that had automatic brakes have in use, they would have been then applied. The train was a long one, and whatever the speed was at the beginning of the disaster, the smash-up itself acted as a passably efficient brake, so that by the time the ninth car reached the further abutment it was practically at a dead stop, with one end only resting on nothing, beyond the abutment. It then (one side having lost its support before the other, because of the skew) quietly turned over and fell into the gap, leaving its rear truck on the bank. The speed was so slow that another correspondent who was in the eighth car writes us that he thought at first that they were going to come to a stop without passing beyond the abutment. His former letter to us, which appeared in our issue of March 26, will make this clearer.

Coming now to the theory of the subject: The computation of brake-efficiency, whether

the braking is done by brakes proper, or by a smash-up, or by both combined, is a much simpler matter than is generally supposed. It is unnecessary to trouble oneself about the absolute weight of the train. A train or any body moving *through space* in a horizontal or vertical or any other direction at a certain fixed velocity has stored in it a certain fixed amount of energy which will just suffice to lift it to a certain fixed height—which may be called the "velocity-head". When the energy which this "velocity-head" represents is all

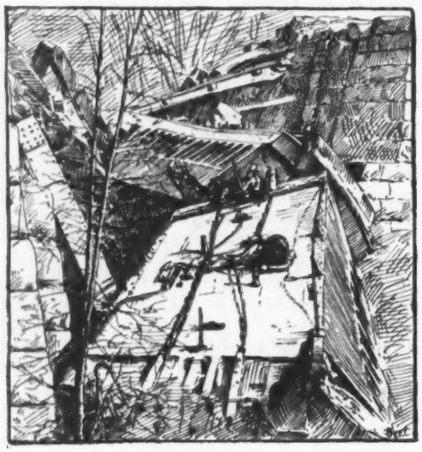


Fig. 1.

The smoker at rear of Bussey Bridge Train, showing the Brake Gear.

[The cleats for attaching the auxiliary reservoir of the automatic brake will be seen in position, but the latter is wanting.]

destroyed the body comes to a rest, and not till then. It may be destroyed by ordinary train friction alone, or by brakes, or by grades, or in any other way. The more rapidly it is destroyed the quicker the stop.

A table of the "velocity-heads" due to all working speeds—the only one of the kind in existence, so far as we know—is given on page 282. The chief practical use for the table is for making in a quick and simple way cer-

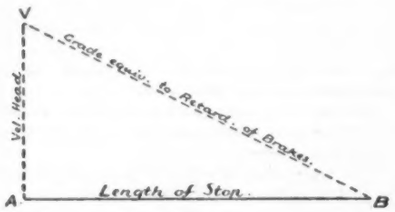


Fig. 2.

[Illustrating the method of computing a brake stop on a level, by the aid of the table given on page 282. The "velocity-head" divided by the length of the stop gives the per cent. of efficiency of the brakes to the total weight of the train, which is equivalent to the rate of an up-grade which would have stopped the train in the same distance without any brakes.]

tain computations connected with the laying out of grades, but it is very convenient for computing brake efficiency. The "velocity-heads" which we have now occasion to use, quoting from the table are:

1 mile per hour	.....	0.04 ft.
2 " " "	.....	0.14 "
5 " " "	.....	0.89 "
15 " " "	.....	7.99 "
20 " " "	.....	14.20 "
25 " " "	.....	22.20 "
30 " " "	.....	31.95 "

The maximum coefficient of friction between brake-shoes and wheels is about ¼, or 0.25, so that if the velocity head were 22.20 ft. (25 miles per hour) a train with all its weight braked in the most efficient way possible, might be stopped in $\frac{22.2}{0.25} = 89$ ft. The equivalent of this has been actually accomplished by an ingenious brake apparatus devised by Mr. GEO. WESTINGHOUSE, Jr., but never in a practical way. Passenger trains differ from freight in having practically all their weight braked, but the most which is practically realized in long trains, with brakes a little off from perfect order, as they naturally must be, is about 10 per cent. That is constantly realized in actual practice, and means that a train moving at 25 miles per hour with all its weight braked would be brought to a stop in a distance of 222 ft. by automatic brakes alone; really somewhat less, because the normal rolling friction helps. We shall assume only 9.5 per cent. efficiency; as there would be no excuse for passenger brakes in actual service falling below that. The manner of making the computation, in theory, is sufficiently indicated below. (Fig. 2.) The practical application of this theory to the particular problem before us is indicated in Fig. 3.

In Fig. 3, the assumed length of the train, 405 ft., or 45 ft. per car, (which is probably somewhat short,) has been laid out as a base-line. The couplings and hose parted (see Engineer WHITE'S testimony elsewhere) as the leading car reached the further abutment. The train came to a dead stop, or almost that, in 285 ft., or its own length less the span of the bridge, which, allowing for skew, we will take at 120 ft. Whether the rear car when it turned over was actually at a dead stop, or moving at 1 or 2 or 5 miles per hour makes little difference. The "velocity-head" at such speeds is so small that it would have been at a dead stop in 6 in. to 9 ft. further in any case.

Then in Fig. 3, as will appear more clearly from the notes below it, the light solid lines, S—15, S—20, S—25, represent to scale the *breaking efficiency of the smash-up* for the three assumed speeds, which may have been anything from 2.8 to 7.8 per cent. according to the initial speed. As to this *average* there is no uncertainty, but there is uncertainty as to when the most efficient retarding work of the smash-up was done. If it was during the first part of the stop these lines S—15, etc., should be concave instead of straight; if it was toward the end of the stop, as in ordinary breaking, they should be convex instead of straight. Actually, in the first

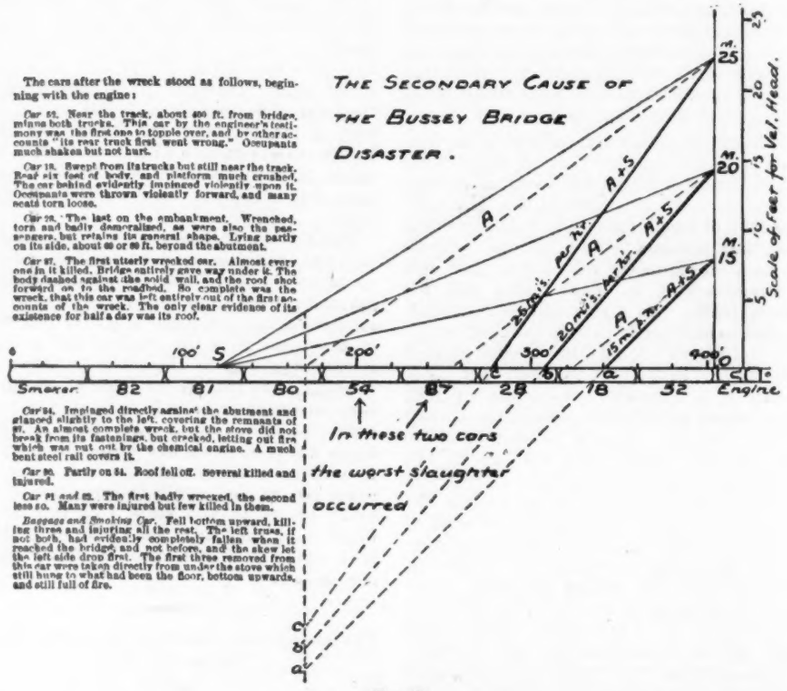

The cars after the wreck stood as follows, beginning with the engine:
Car 83. Near the track, about 400 ft. from bridge, minus both trucks. This car by the engineer's testimony was the first one to topple over, and by other accounts "its rear track first went wrong." Occupants much shaken but not hurt.
Car 18. Swept from its trucks but still near the track. Rear six feet of body, and platform much crushed. The car behind evidently impinged violently upon it. Occupants were thrown violently forward, and many seats torn loose.
Car 32. The last on the embankment. Wrenched, torn and badly demoralized, as were also the passengers, but retains its general shape. Lying partly on its side, about 60 or 80 ft. beyond the abutment.
Car 87. The first utterly wrecked car. Almost every one in it killed. Bridge entirely gave way under it. The body dashed against the solid wall, and the roof shot forward on to the roadbed. So complete was the wreck, that this car was left entirely out of the first accounts of the wreck. The only clear evidence of its existence for half a day was its roof.
Car 34. Impinged directly against the abutment and glanced slightly to the left, covering the remnants of 87. An almost complete wreck, but the stove did not break from its fastenings, but cracked, letting out fire which was put out by the chemical engine. A much bent steel rail covers it.
Car 28. Partly on 34. Roof fell off. Several killed and injured.
Car 21 and 18. The first badly wrecked, the second less so. Many were injured but few killed in them.
Baggage and Smoking Car. Fell bottom upward, killing three and injuring all the rest. The left truck, if not both, had evidently completely fallen when it reached the bridge, and not before, and the skew let the left side drop first. The first three removed from this car were taken directly from under the stove which still hung to what had been the floor, bottom upwards, and still full of fire.
THE SECONDARY CAUSE OF THE BUSSEY BRIDGE DISASTER.
Scale of Feet for Vel. Head.
25
20
15
10
5
A+S
A
A-S
25 mi's per hr.
20 mi's per hr.
15 m. p. hr.
100'
200'
300'
400'
S
O
Smoker
82
81
80
34
87
28
21
18
32
Engine
In these two cars the worst slaughter occurred
c
b
a

Fig. 3.

[The scale of feet at the side is that on which the velocity-heads corresponding to 15, 20 and 25 miles per hour were laid out, as given in the accompanying table. The point S is the one which was (or would have been, except for the wreck) at the point O when the train came to a stop, and the rear car S toppled over into the chasm. The lines S—25, S—20, S—15 represent to scale the breaking efficiency of smash-up in stopping the train in the distance S O=285 ft. The dotted lines A represent by their intersections with the base-line S O the distance in which the train would have been stopped by air brakes alone.

To determine graphically the compound braking efficiency of automatic brakes and the wreckage: Erect the dotted vertical *a' b' c'* through the point where the dotted line *A*—25 cuts the base-line S O. Take in a pair of dividers the distance O—M 25, and lay it off on the vertical starting from its intersections with the lines A—25. *A*—20, *A*—15 successively, thus fixing the points *a' b' c'*. Connect by a right line *c'*—M 25, *b'*—M 20, *a'*—M 15. Then will the intersections of these right lines with the base-line S O give the points *a b* and *c*, *which indicate the distance in which the train would* have been stopped.

The same result will be reached by laying off the distance O—20 M or O—15 M on a vertical erected through the points where the corresponding lines *A* cut the base line S O.

To determine the same results by computation:

At assumed speed of	Vel. head is	Which ÷ distance (2.85) gives	Adding 9.5, = p. c. efficiency due to brakes, gives	Which divided into vel.-head gives
15	7.99 ft.	2.8	12.3	65 ft.
20	14.20 ft.	5.0	14.5	96 ft.
25	22.20 ft.	7.8	17.3	128¾ ft.

The last column corresponds in substance (should correspond exactly) with the distances *Oa*, *Ob*, *Oc*. *The distances Sc*, *Sb*, *Sa* show the length of train which should have been left on the bank, back of the abutment, when the train came to a stop, according to the preceding computations, being from 3¾ to nearly 5 cars, according to the assumed speed.

three car-lengths of the stop trucks were stripped from the cars by jumping over the gap in the roadbed, and the car-bodies then pushed along, one being telescoped, over the solid ground. The bridge then broke at the further end, and the fourth car was crushed bodily against the abutment. There was thereafter a powerful gravity pull from the cars running down the inclined plane of the broken bridge. As a whole, most of the retarding work, was probably done in the first half of the stop. We will assume, however, that the retardation from the smash-up was uniform throughout the stop,

which certainly will not exaggerate the possible quickness of stop, but rather understates it.

The dotted lines marked *A* show the distance in which automatic brakes alone would have stopped the train, without aid from the smash-up, acting with the assumed efficiency of 9.5 per cent., which will be seen to have been from less than two to a little more than five car lengths.

Actually, however, the smash-up retardation and the brake-retardation (had there been any) would have acted together and THE SOLID LINES MARKED "*A* + *S*" SHOW WHAT BOTH TOGETHER WOULD HAVE DONE, viz., they would have stopped the train when the successive points *a*, *b* and *c* reached the further abutment or the point near to it where the brake-hose broke. In other words, THE TRAIN WOULD HAVE BEEN STOPPED BEFORE THE TRUSS PROPER BROKE, EVEN AT THE HIGHEST PROBABLE SPEED. Even had we included in the diagram an assumed speed of 30 miles per hour the result would have been little different, as may be seen by laying off on the diagram the velocity head corresponding to 30 miles per hour (31.95 ft.) and constructing the proper lines for it.

Now let us see what these facts mean. A record of what happened to each car, reproduced from our issue of March 19, following the disaster, is given in connection with Fig. 3. In the first three cars many were scared and not a few injured but only one man killed, (if we recall correctly) and he was on the platform. The shock to these cars with automatic brakes might have been less, but not materially different, if the speed was in fact as high as 25 miles per hour. In fact, in one respect it might have been very much worse. TIME was the important element in the fall of the bridge. Had the train been stopped in less than these three car-lengths, as automatic brakes would have stopped it the total time to move that distance would have been about twice as great as it was, and what actually happened to the fourth car—to be dashed bodily against the face of the abutment by the final giving way of the truss—might well have happened to the second or third car, especially as the slower speed would have let the leading trucks drop down deeper in jumping over the gap. But the diagram will show it to be more probable that the final breakage of the truss would have happened about *the middle* of the second car, instead of at *the end* of the third car, which was at just the right instant to do the greatest damage to the fourth and fifth cars.

Passing this point, however, all the six cars back of the leading three would practically have escaped unharmed. The bridge would still have been loaded with them when it fell, but it would have been a DEAD fall, with little or no velocity left in the train to make it crowd distructively on the head cars, even if the bridge had fallen a car-length or so sooner than it did, as it probably would have done. A dead fall of some 30 ft., with the breaking bridge below to cushion it, would not have been likely to cause any great loss of life or injury. The overturning of the trucks, which killed 3 and injured all the rest in the car, would have been likely to have been saved altogether. On the whole, it is at least highly probable that a death-roll of 8 or 10, and a proportionate number of injuries might have told the whole tale of the disaster. In any case its effect would certainly have been much ameliorated.

So far as we can recall, no more notable instance than this of the value of the automatic feature has occurred in the whole history of the automatic brake. The circumstances were quite different here from those at Asthtabula, where the higher speed and great depth of fall made the question of brakes or no brakes of no moment. But in the Roslindale disaster, or in such cases as the broken bridge and wrecked freight train which we picture elsewhere in this issue, it becomes of the highest importance, so much so as to make it practically certain that the freight train brake of the future, whatever else it may be, will have the automatic feature. The subject invites further discussion, but our space in this issue forbids.

The Causes of Bridge Failures.

We present in another column an interesting letter from Mr. CHAS. F. STOWELL, engineer of the New York Railroad Commission, giving what we presume is the most correct list of bridge failures for the past year in existence. It shows in all, 21 cases of wrecked bridges, divided as to material and causes of fall as follows:

	Iron Bridges.	Wooden Bridges.
Abutments washed out	1	1
Collision on bridge	0	1
Horses and cows on bridge	2	0
Knocked down by derailments	4	1
Cyclone	1	0
Projections from cars	1	0
Fire	0	4
Overloading narrow-guage bridge	1	2
Weakness and old age, st'd. gauge	0	1
Unknown	0	1
Total.	10	11

Here it will be seen that 4 bridges, 1 iron and 3 wood, only one of the wooden ones being to standard gauge, fell from inherent weakness or overloading, while 17 fell from other causes. This record covers a different period from the one we made up, which was for a year, but not precisely for the calender year. Hence some discrepancies are natural, although the essential moral of the two tables remains the same. That there were not more discrepancies than there are is wonderful in view of the imperfections and incompleteness which Mr. STOWELL's letter reveals in the record on which we relied, which was that which has been kept for many years by the *Railroad Gazette*. We have long known that record to be a very incomplete one as respects accidents in general, nor does it profess to be anything else, being made up only from such accidents as are reported in the newspapers. The vast majority of minor train accidents would thus naturally be lacking. But bridge failures are a special class of accidents nearly always serious, and every one of them, with possibly rare exceptions, "put upon the wires" and quite extensively reported. We must confess, therefore, that we did suppose that, as respects this special class of accidents, the record would be tolerably complete, and admit our extreme astonishment to find that of the bridge failures reported by Mr. STOWELL *nearly half* have been omitted, viz., 10 out of 21, as follows:

Bridge Failures in the Calendar Year, 1886.	*Nos. in* MR. STOWELL'S *letter given elsewhere.*
Reported in the *Railroad Gazette* record.	Nos. 1, 6, 7, 10, 11, 14, 15, 16, 17, 19, 21 = 11 in all.
NOT reported in the *Railroad Gazette* record	Nos. 2, 3, 4, 5, 8, 9, 12, 13, 18, 20, = 10 in all.

On the other hand, there were *no* bridge failures proper which the *Railroad Gazette* record gives, and Mr. STOWELL does not, unless that of Sept. 6, ("small wooden bridge," which was probably a trestle) may be an exception. In the accidents which the *Railroad Gazette* reports, besides the exceptional No. 6, in which 21 were killed or drowned, there were 7 killed and 31 wounded. In those which it does not report there were likewise 7 killed and 7 injured.

If such imperfections exist in the most conspicuous class of all bridge accidents it is difficult to estimate how great may be the imperfections in the remainder of the record. However imperfect, the record is a very valuable one in many ways, and the only one which exists for the past, but we commend to our contemporary the motto, "whatever is worth doing at all is worth doing well." Such astounding imperfections as these should not exist.

But the corrected record sustains as well as the imperfect one the position we took, that the fall of iron bridges from inherent weakness is a very rare event and that it is a gross abuse of language to say that 20 or 40 bridges per year, "fall down" or "break down," when the fact is that the vast majority of them "fall down" from quite other causes than their own defects. Supposing we should say of some engineer, for example, that "he had been drinking at the society rooms, and on returning at a late hour, fell into the gutter, where he lay all night," when the fact was that he had taken a glass or two of that innocuous and insipid compound called "claret punch," and in returning home was knocked on the head with a sand club and lay till daylight unconscious, as actually happened to a member of the American Society of Civil Engineers some years ago? We have told the truth in a literal sense, but in another and a truer sense, we have told a lie, and so it is with bridges, although it is as literally true of a bridge as of a man that every bridge knocked down, "breaks" down and "falls" down.

CORRESPONDENCE.

Bridge Failures in 1886.

ALBANY, N. Y., April 20, 1887.

EDITOR ENGINEERING NEWS:

In the current number of the ENGINEERING NEWS some editorial strictures are made on the list of bridge failures during 1886 as stated by Mr. GEO. L. VOSE, accompanied by a list of such accidents which happened during that year. The list, however, is very far from complete. I have taken pains to ascertain the circumstances of all such accidents, as far as possible, and herewith beg to submit a brief statement of those reported in 1886 together with the circumstances as far as could be learned in each case. This list does not include accidents to trestles nor to simple stringer bridges, as cattle-guards, etc. It will be seen that the facts in the case could not be obtained in every instance, but where a bridge is put down as of unknown construction, or falling for an unknown reason, possibly some of your readers may be able to give the facts, in order to make the record complete. A *complete* record of this sort, kept from year to year, will be interesting and valuable.

BRIDGE FAILURES IN 1886.

1. Jan. 4.—*Pennsylvania R. R.* Old iron Pratt truss bridge near Duncannon, Pa., broke under freight train. Bridge had previously been strengthened by cast-iron arches after the manner of strengthening old Howe trusses by wooden arches. Afterwards a pier was built under the center of each span and the arches removed. *A freshet washed out one of these center piers* and a freight train soon after came on the bridge which then broke down, wrecking engine and 8 cars, killing 1 man and injuring 6 more.

2. Jan. 8.—*Louisville & Nashville R. R.* Howe truss or combination bridge near Wilhite, Ala., *knocked down*. Freight train broke in two, and rear portion stopped on bridge. Following freight ran into it and the shock of the collision *knocked down* one span of bridge, wrecking engine and 28 cars, killing 2 men and injuring 2 more.

3. Feb. 19.—*Wilmington, Columbia & Augusta R. R.* Iron Bollman truss, 150 ft. span, *knocked down*. Box car in freight train left track on approach to bridge over North East Cape Fear river at Hilton, N. C., struck end post of bridge and *knocked down* one span. 7 cars wrecked.

4. March 2.—*New York, Ontario & Western R. R.* Iron Pratt truss bridge, 144 ft. span, at Fish's Eddy, N. Y., was struck by derailed caboose of freight train and one span *knocked down*; 5 cars wrecked; 4 men were killed,

but *not* by the fall of the bridge. Built by the Central Bridge Works in 1882.

5. March 15.—*St. Louis, Keokuk, & Northwestern R. R.* Wooden bridge over Clear Creek near Louisiana, Mo., broke under freight train. *On fire.*

6. March 29.—*Columbus & Western R. R.* Construction train broke through bridge near Opelika, Ala. Whole train wrecked, 2 men killed and 19 drowned. Abutments said to have been *weakened by freshet.*

7. April 19.—*Atlantic & Pacific R. R.* Wooden bridge *on fire* near Aubrey, Ariz., broke under passenger train. Engine and 2 cars wrecked and 2 persons injured.

8. April 30.—*Missouri Pacific R. R.* Bridge over Pottawottomie River near Osawatomie, Kan., broke under freight train. Eight cars wrecked. *Kind of bridge and cause of failure not ascertainable.* Appears to have been a "square fall."

9. May 11.—One span of bridge over Missouri River at Kansas City reported to have been *destroyed by cyclone.*

10. May 30.—*Boston & Lowell R. R.* (Northern of New Hampshire Division). Bridge near Lebanon, N.H., broke under freight train; an old covered wooden structure of the "Childs" pattern, built in 1865. Broke in two in the middle from *sheer weakness and old age*; 124 ft. span.

11. June 7.—*Canadian Pacific R. R.* Through iron Whipple truss bridge over Petewawa River, near Pembroke, Ont., *knocked down* by freight train; 5 cars wrecked, 2 men killed and 2 injured. Built by Clark, Reeves & Co. A steam shovel in the train was a little too high to pass under the portal bracing, which being struck the end posts were lifted off their seats and the span collapsed.

12. June 17.— *Chesapeake & Ohio R. R.* Through iron, plate girder bridge, 51 ft. span, struck by derailed train and *one end knocked off the abutment.* Train fell over on the bridge, but it was not very seriously damaged. Built (probably) by Keystone Bridge Co.

13. July 6.—*Chicago, Milwaukee & St. Paul. R. R.* Bridge on Andover branch, 25 miles north of Aberdeen, Dak., broke under freight train. Engine and 14 cars wrecked and 1 man injured. Said to have been caused by *broken axle.* No particulars to be had about bridge.

14. July 27.—*Toledo, Peoria & Western R. R.* Wooden bridge 40 ft. span, over Crooked Creek near Burnside, Ill., broke under passenger train. Engine and 2 cars wrecked, and 10 persons injured. Bridge had been *partly burned the previous night.*

15. July 31.—*Toledo, St. Louis & Kansas City R. R.* [*Narrow-gauge.*—Ed.] Old and decrepit Howe truss bridge over Wabash river at Bluffton, Ind., broke under freight train which was crossing very slowly. Engine and 8 cars wrecked, 2 men killed and 2 others badly injured. A *square break-down.*

16. Aug. 18.—*Central Vermont R. R.* (Narrow gauge Div.) Bridge near Brattleboro Vt., broke under mixed train. Engine and 10 cars wrecked, 2 persons killed and 6 others injured. Bridge was a combination Pratt truss, 216 ft. span, designed by A. P. Boller and built by C. E. Danforth & Co., of New York, in 1879, the iron work being done by the Keystone Bridge Co. It was designed for a moving load of only 1,000 lbs. per ft., and had been *badly overloaded* for a long time. From the appearance of the wreck it would seem that the immediate cause of the fall was the "buckling" and springing upward of one of the top chord sections.

17. Aug. 21.—*Burlington, Cedar Rapids & Northern R. R.* Passenger train broke through bridge near Norris, Ia. One man injured. Wooden bridge, *on fire.*

18. Sept. 16.—*Baltimore & Ohio R. R.* Freight train struck horse on bridge near Independence, O., *knocking down* one span, wrecking engine and 1 or 2 cars, killing 1 man and injuring 2. Bridge was an iron Pratt truss, built in 1881 by the Clark Bridge Co.

19. Sept. 24.—*New York, Susquehanna & Western R.R.* Bridge over Dundee lake, near Paterson, N. J., broke under freight train. Bridge was a new iron Pratt truss, about 132 ft. span, designed and built by the Passaic Rolling Mill Co., but erected by the railroad company. An old wooden bridge was being renewed in iron. One span was completed and had been in use a few days, while an adjoining duplicate span rested on false work. An ordinary, light way freight was crossing the bridge very slowing—not more than 5 or 6 miles an hour. The engine had just passed on to the farther abutment when the completed span fell, wrecking 6 cars and injuring 1 trainman. No particulars ascertainable as to the cause of the accident, but it is not unlikely that the second or third car back of the engine *jumped the track* on the bridge and struck one of the long vertical posts of the truss. [We have ascertained that this was certainly the case.—Ed.]

20. Oct. 28.—*Cincinnati, Washington & Baltimore R. R.* Freight train struck cow on approach to bridge near Greysville, O., throwing train from track, striking and *knocking down* one span of bridge; 17 oil cars wrecked. Bridge was an iron Whipple truss, about 120 ft. span, built by the Keystone Bridge Co. in 1873 or 1874.

21. Nov. 13.—*Toledo, St. Louis & Kansas City R. R.* [*Narrow-gauge.*— Ed.] Bridge over Kickapoo river, near Charleston, Ill., broke under freight train. 11 cars wrecked and one man injured. A "*square fall,*" and due to the same cause that wrecked the bridge at Bluffton, Ind., on the same road on July 31.

A number of other bridge failures were reported during the year, which on investigation, were found to be incorrectly given. Thus on March 2, it was reported that a train on the Grand Trunk R. R. went through an iron bridge, near Belleville, Ont., making a bad wreck. The accident happened on a wooden trestle. On May 24, a bridge on the Western North Carolina R. R. near Round Knob, N. C. was reported to have been knocked down by a train. It was another wooden trestle. The same thing was reported in regard to another trestle accident on the Chicago and Alton R. R. near Slater, Mo., on June 10.

The writer will be pleased to hear of any additions, or corrections, which will make this list more nearly perfect.

It will be noted that, of the seven iron truss bridges in the above list which fell, or were knocked to pieces, not one was of the riveted lattice type, though there was at least one accident during the year, in which such a bridge was struck by a derailed train, and the end post and adjacent web-members pretty thoroughly demolished. The shock was certainly very much more severe than that which wrecked the Dundee Lake bridge for instance, but the riveted lattice did not go down. They are not in the habit of doing so.

Chas. F. Stowell.

The Utica Water-Works Co., of Utica, N. Y., has elected the following board: President, Thomas Hopper; Vice-President, A. G. Brower; Secretary, J. K. Chamberlayne; Treasurer, Publius V. Rogers; Superintendent, Charles W. Pratt; Directors, G. C. Churchill, C. A. Butler, Wm. Kernan, J. H. Wood and Theodore Sayre.

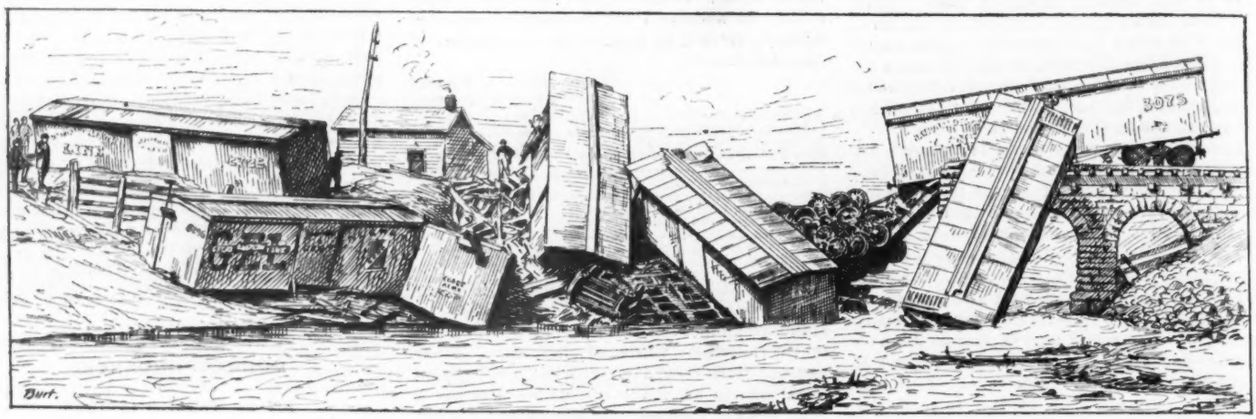
Abutments Washed Out.

Morrisburg, Ont., April 25, 1887.

Editor Engineering News:

I send you herewith an account of the railway accident at Nash's creek, near this place, on Friday last, April 22, at 4.15 A. M. The enclosed description was given to me by the editor of the local paper here, in which it will appear next Wednesday. I visited the scene of the wreck, and as near as can be learned, the masonry was not defective. Nash's creek, until within the last year or so, was simply a quiet *mill pond*, but the mill dam was then carried away. Since that time, during the spring and fall freshets, the "mill pond" has developed into a roaring torrent, and rushes madly under the railway bridge; and the general impression is that the constant rushing of the water about the stone abutment undermined it. The masonry inspector of the Grand Trunk Railway inspected the bridge abutments two days before the accident, and pronounced them all right. The engineer and fireman were killed and 13 cars wrecked. The fast passenger train passed over the bridge but a few moments before; had it been that train which went through the bridge, it would have been another White River and Roslindale affair. The engine went down first, out of sight, and of course with it the engineer, and 13 cars on top of it. It was daylight at the time. The other man who was on the engine, and was saved, says the whole structure seemed to simply *sink beneath him.* Yours truly,

M. Battle.



ABUTMENTS WASHED OUT.
Wreck on the Grand Trunk R. R., near Morrisburg, Ont., April 22, 1887.

[We have to thank our correspondent cordially for getting us such prompt particulars of this affair, and to express the hope that his example will be generally followed. The probable cause of the disaster seems very clear: That no particular pains were taken to get deep and sound foundations in the original "mill pond." There was then no current to fear, while there was no doubt, a considerable depth of water to impede foundation work. The moral is,—but it is unnecessary to draw the moral; it is enough to draw a picture of the wreck. The further details of general interst in the enclosed account above referred to were as follows. We omit the testimony taken at the inquest, which is not unfairly summarized in the article of the local paper.—Ed, Eng. News.]

"The fast passenger train had passed over the bridge but a short time previous, and it is fortunate it was not the ill-fated one. The sight was a wild one and something witnessed but once in a lifetime, and will never be forgotten. The engine was beneath, with the dead driver at his post, and the cars and debris piled on top of it and on either side, while the water, high at this season of the year, rushed madly by the scene.

"The cause of the disaster is hard to determine, as all the railway employés declare the bridge was in no way defective, and the masonry inspector, iron bridge inspector, road inspector, assistant engineer and

section foreman were all in the witness box at the inquest on the bodies of the victims. Last September some defects in the abutments were remedied and those in charge testified that the work was well done. But a few days previous the road inspector and masonry inspector examined the bridge while the inspector of iron bridges had just examined the structure the day before the accident. These men all adhered to the belief that the bridge was not defective. On the other side of the question, the theory is this: When this bridge was built the water there was but a mill pond, a dam keeping the water in check. About a year since, this dam was taken away and consequently at high water there is a very swift current which sweeps in a curve with great force against the west abutment, which is now gone in the wreck. Some citizens contend that this water had undermined the foundation of the abutment which caused the collapse. There appears to be some ground for this opinion, as the bridge collapsed at the west end, and the mason work is entirely demolished to the water's edge; and while the iron girders at that end are in the water, at the east end they remain in position. In the evidence it was also shown that the repairs done last September consisted of filling defects in the west abutment with small stone and cement, though the section foreman at Morrisburg gave it as his opinion that the west end was no weaker, but if anything safer, than the east end. However, the fact remains that the failure was at the west end, and notwithstanding all the force of the smash-up, the east abutment and arches remain intact, while the 24 ft. span gave way at the other end. We might say that the bridge consisted of arches, except for the one span which gave way."

The Testimony as to the Brakes at the Fall of the Bussey Bridge.

The following from the Boston *Evening Record* report, April 1, 1886, is all the evidence taken at the Bussey bridge hearing, which we have been able to discover, bearing upon "The Secondary Cause of the Roslindale Disaster," which we have discussed elsewhere.

Engineer WHITE testified that the engine was carrying about 100 lbs. of steam when leaving Roslindale and about 90 lbs. when crossing the bridge. When the accident happened was running about 15 miles an hour. Only let on just enough steam to start the engine from the station. Sometimes the brakes act badly, and it is hard work to start the train, and it is often difficult to keep on time when this is the case. On the morning of the accident the brakes were working all right when the train left Roslindale. The brakes are "straight air" brakes. Do not think any of the brakes were worked by hand. Did not examine the wreck to see if any of the brakes were set. Do not remember seeing the top of the fourth car on the abutment. Am very sure that the train was not moving more than 15 miles an hour. The train runs quite a way from Roslindale before the brakes are let off. Do not know whether there were any automatic brake cars on the train or not, but think there was one. Am sure I did not apply the brakes after leaving Roslindale. After leaving the bridge, there was no use in applying the brakes, as my engine was disconnected from the train.

The first car let go from the engine just as we reached the abutment. Felt the rise of the forward wheels just as the engine came to the abutment; the shock was heavier on the right hand side. The car broke away from the engine at the moment when it struck the abutment. When I looked back the car was running on the ties. When I saw the second car it was sliding along the rails without any trucks under it. It was separated from the first car. I then reversed my engine, put on steam at once, and ran to Forest Hills for assistance. Did not notice that the rails were torn up.

I am confident that I saw the second car, and that there were no trucks under it.

Fireman BILLINGS, recalled, testified that the steam was decreasing that morning all the time after leaving Dedham. Started from Dedham with 130 lbs. of steam. He didn't know how wide open the throttle was, and he didn't remember any particular remark about the working of the brakes that morning. The brakes were not applied that morning between Roslindale and the bridge. Should think the train was running about 15 miles an hour the morning of the accident, and less rather than more than that. He was sure there were no trucks under the second car when he saw it after returning from Forest Hills to Bussey bridge subsequent to the accident.

To Mr. KINSLEY witness said he couldn't safely jump off his engine when the train was running 12 or 15 miles an hour.

Supt. A. A. FOLSOM said to the chairman that there were cars in that train which had automatic brakes; couldn't tell which ones, but would furnish a statement later. Whether they were automatic or straight-air, they were practically straight-air.

A correspondent who was on the train writes us that there were no cars with the automatic reservoirs on them in the fated train, and that the same train, as it is now running (April 21) has eight cars, of which one has an automatic auxiliary reservoir and seven have not.

TECHNICAL NOTES.

HUTCHINSON, Kansas, has under one roof, and controlled by one company, a Holly water pumping plant, a 2,000-light Edison street-lighting plant, and a telephone exchange with 150 subscribers.

ALL the trains on the Lake Shore Road are to be supplied with "emergency cases"—boxes containing an assortment of bandages, rubber bands, splints and other articles that are needed in the event of an accident.

THE Worcester, Mass., Technical Institute has received a gift of $100,000 from Mr. STEPHEN SALISBURY to be expended in building a mechanical, physical and chemical laboratory. The father of Mr. SALISBURY was long president of the board of trustees of the Institute, and he couples his father's memory with his gift.

THE rails intended for the Suakim-Berber railway, and transported to Egypt and back again are now said to be doing duty (turned upside down) as a "tennis court" in a soldier's summer camp at Lydd, on the Sussex coast of England.

THE College of William and Mary, in Virginia, founded in 1693 by royal grant; the next oldest in this country to Harvard; the institution that gave Washington his degree as a civil engineer, and trained in law and politics, JEFFERSON, RANDOLPH, MARSHALL and a host of other luminaries, has not now a single student.

THE English *Railway News* speaks of the rumored letting of a contract for a railway from Chinley to Dore, near Sheffield; which "will have six or seven miles of tunneling in its total length of 20 miles." The road runs mainly through the estates of the Duke of Devonshire.

THE Island in the Susquehanna river, which now supports a portion of the new Baltimore & Ohio R.R. bridge near Havre de Grace, Md., was actually granted in 1624 for the "Foundinge and maintenance" of a university by the Virginia authorities. This institution was to be called the *Academia Virginiensis et Oxoniensis*, and the site was suggested by the necessity for selecting some spot safe from a repetition of the Indian massacre of 1622, in which some 340 settlers lost their lives. So says Neill's *Virginia Vetusta*.

IT IS alleged that there has been discovered on the North Saskatchewan river, about 70 miles above Edmonton, Alberta, a layer of naturally reduced iron. The strata consist of lignite over clay, shales and soft argillaceous sandstones containing nodules of clay iron-stone, which are about 35 per cent. iron. The outcroppings of lignite have been burned and "from the mass of burnt clay pieces of metallic iron can be picked out, weighing, in some cases, 15 or 20 lbs.," which it is claimed have "evidently been reduced from the nodules by the heat of the burning lignite." We tell the tale as 'twas told to us, in *Engineering*, and it may be so.

LIEUT. E. L. ZALINSKI, in a late address before the Military Service Institute, said that while he suggested the dynamite gun as a practical military appliance and directed its development, the mechanical details were all worked out by Mr. N. W. PRATT, of the Babcock & Wilcox Co., and Mr. GEO. W. REYNOLDS and Mr. CHAS. E. EMERY both aided materially in bringing about success. The electrical fuse is alone his personal invention.

A GUN larger even than any of the monsters hitherto produced is now under construction by KRUPP. It is 52½ ft. long and weighs 315,000 lbs., although only 15¾ ins. in bore. Its lightest projectiles will weigh 1,632 lbs., and will be propelled by 1,070 lbs. of prismatic brown powder.

CONSTRUCTION NEWS.

Water.

Tyler, Tex.—The water-works have been purchased, and will be extended, by Col. J. W. PARAMORE and Capt L. B. FISH, of St. Louis, Mo. The price paid was $12,500 and the city will have 18 hydrants free for three years Several improvements will be made.

Birmingham, Ala.—A contract will be made with the Birmingham Water-Works Co. by which better water facilities will be obtained. The company will put in high pressure hydrants and 78 additional fire plugs The city will then have 200 water plugs and an ample pressure for fire purposes.

Filter Infringement Suits.—In our issue of March 26 we noted that suits had been brought by the Newark Filtering Co. against the National Water Purifying Co. and others, for alleged infringement of their patents.

The National Water Purifying Co. give answer to said notice by a public announcement, which will be found under their regular advertisement on the third page of this issue.

The theory of the case on the part of the National Water Purifying Co. is that they hold the foundation patents, covering the principle of surface washing, and that said patents antedate the Hyatt patent by several years.

Oakland (Cal.) Water.—The City Council of Oakland has decided to continue the present water rates, which will average about a cent a slab. A slab, as defined for the purpose of the ordinance, is a piece of water 3 ft. long, 2 ft. wide, 6 in. thick, and of the standard consistency, which is a little firmer than that of oatmeal mush, and not quite so firm as that of calves-foot jelly. In former years—up to 1884—Oakland water was paid for by the roll, but the present system is simpler, for the liquid had to be measured in the slab, as now, before rolling. An effort was made this year to substitute the coil as the unit of quantity—all consumers to use ¾ in. faucets, and a coil to be as much of the outpush as could be wound upon a reel of stated dimensions. The notion was abandoned on account of the liability of the health-giving fluid to disruption. In certain states of the weather it is so damp that it parts like a rotten hawser, and at other times it is brittle and snaps when bent. But it is found that, after being pulled out of the pipes by an ingenious appliance which the company sells for that purpose, it will sufficiently deliquesce to take the shape of the containing vessel—a process called slabbing, the vessel being commonly of such shape and dimensions as to enable the consumer to measure the water, and check the company's meter.—*The Engineer*.

Toronto, Canada.—There is considerable discussion over the proposed water supply by gravitation. Assistant City Engineer ALAN MACDOUGALL recently visited St. Catharines, Ont., which is supplied with water by the gravity system; he thinks the result at St. Catharine proves the practicability and advisability of getting a supply for Toronto from the lake to the north of the city.

Montclair Water-Works.—The Montclair (N. J.) Water Co. has commenced operations in pipe-laying. The supply will come from a well sunk in the old-red-sandstone, 30 ft. in diameter, and 50 to 75 ft. deep. Two Worthington pumps of 500,000 galls. each will force water to a 300,000 gall. reservoir on a hill near by; about 21 miles of pipe will be required. Test wells sunk show an abundance of pure water. The engineering work is being carried out under the direction of Mr. JAMES OWEN, Engineer of the Township of Montclair, and Mr. GEORGE W. HOWELL as engineer for the water company. MCNAMEE & Co., of Brooklyn and Montclair, are the contractors.

Syracuse, N. Y.—A bill has been introduced into the State Legislature by Assemblyman THOMAS MCCARTHY to authorize the city to purchase the plant and property of the Syracuse Water Co. for not more than $675,000, and to issue bonds in payment. If the purchase is made all the powers and privileges of the company to be acquired by the city and the management and control to be vested in a board of four commissioners.

Rockaway Beach, L. I.—(A CORRECTION.)—In the item in our issue of last week (p. 274), it should have been stated that the Queens County Water Co.'s extension to the beach will be *eight miles* long instead of an eighth of a mile. Mr. MULLINS, Chief Engineer, asks us to make this correction, as it might puzzle hydraulic engineers to account for an annual hydrant rental of $2,000 on less than 700 ft. of pipe.

Water Companies.—The Salmon River & Onondaga Water Co. has been incorporated by MOSES R. CROW, WM. HASKILL, and others, with a capital stock of $5,000, with power to increase, to supply Syracuse, N. Y.—The Crystal Springs Water Co. has been incorporated at San Francisco, Cal., to supply San Mateo: capital stock, $50,000; BEN MORGAN, R. E. RAMMOND and others.—The Sedalia Water-Works Co. has been incorpor-

ated by WM. B. QUIGLEY, and others, of St. Louis, Mo., to build works at Sedalia, Mo.; capital stock, $200,000.——Helena Water Co., of Salem, O.; capital stock, $300,000.——The Salem Water Co., of Perry township, Columbiana county, O.; capital stock, $300,000.——The Flume Co., of San Diego, Cal., has placed $600,000 of bonds and will bring the water from the head waters of the San Diego river, 36 miles.——The Visitacion Water Co. has petitioned to be allowed to supply a portion of south San Francisco, Cal.——At Greenville, Miss., a water company has been organized.

Mission Ridge & Chattanooga Water Co., Chattanooga; JOHN A. HART.——Rochester Water Co., Rochester, Pa.; JOHN M. BUCHANAN.——Amenia Water-Works Co., Amenia, N. Y.; supply from 3-in. driven wells pumped by wind power to a reservoir; capital stock, $7,000.——Camden & Rockland Water Co., Camden, Me.——East Hartford Water-Works Co., Hartford, Conn.——Rockport Water-Works Co., Rockport, Ind.; capital stock, $25,000: ALBERT H. KENNEDY and others.——Jamaica Water Supply Co., Jamaica, N. Y.; JOHN C. LOCKWOOD, P. S. SWAIN, of Brooklyn, and others; capital stock, $75,000.——Waukesha Water-Works Co., Waukesha, Wis.; capital stock, $200,000; F. W. HAIGHT and others.——A new water-works company has been organized at Chester, Pa. Mayor FORWOOD is President.

Hyde Park, Ill.—The reports of the Board of Trustees and of the village officers for the year ending April 1, 1887, have been published. The report of D. A. PIERCE, President of the Board of Trustees, states that applications have been made by street railroad companies, using either horses, locomotives or the cable system, but in only one case has permission been granted, and that to the Chicago City Railroad Co. for a cable line; no definite action has been taken by the Board on the proposed elevated road. The Department of Public Works has been thoroughly reorganized. A new bridge is to be built across the Calumet river this summer. The question as to whether the sewage shall be discharged into the Illinois river instead of into Lake Michigan is not yet decided. The water supply is reported to be free from sewage contamination; a contract has been made to supply the town of Lake with water from the tunnel. The total amount of water pumped, from March 1, 1886 to March 1, 1887, was 1,711,645,345. The new Gaskill pumping engine, of 12,000,000 gals. daily capacity, was started in July, and in September was tested by CHARLES HERMANY, Superintendent of Water-Works, Louisville, Ky.; the results of the test were entirely satisfactory. The village now has 72 miles of macadamized streets, 250 miles of graded streets 33 miles of sewers, 148 miles of wood and 6.5 miles of stone sidewalks, 77 miles of water pipes, 605 hydrants and 51 meters. The work for the current year includes 13.25 miles of macadamized roads, 7.5 miles of sewers and 12 miles of water pipes. A. V. POWELL, C. E., is Superintendent of Public Works; G. L. CLAUSEN, C.E., Assistant Engineer; JOHN E. COWLES, Water Commissioner; ROBERT HAWKINS, Superintendent of Water-Works and JAMES WALLACE, Superintendent of Water Pipes.

New Water-Works.—Washington, Pa. Works are to be put in at a cost of $100,000.——Newark, N. Y. Works will be put in by Moffet, Hodgkins & Clark, of Watertown, N. Y.; there will be eight miles of mains and 69 hydrants; the pumps will have a daily capacity of 1,000,000 gals., and the annual rental is to be $2,000.——Old Orchard Beach, Me. A supply will be obtained from Phillips spring; estimated cost, $40,000.——Oakland, Cal. The Council proposes to buy out the Contra Costa Water Co. for $4,500,000.——Rochester, Minn. Work is in progress on the new water-works.——Dixon, Cal. Water-works will be erected by Joseph Enright, at a cost of $20,000.——Waco, Tex. The new works will soon be begun by Inman Bros.——Rock Falls, Ill. A supply will be furnished by the Sterling Water Co.——Little Falls, N. Y. An 8-in. main is being laid across the canal.——New Albany, Ind. The water mains will be extended.——Bath, N. Y. The water company proposes to put in 35 hydrants for an annual rental of $1,200.——Bismarck, Dak. The new works, which will cost $100,000, will be built at once.——Pulaski, N. Y. The new works are nearly completed.——Sioux Falls, Dak. The pipe system will be extended 1,000 ft.——Stockton, Kan. Work was commenced last week; the system will cost $30,000. President, CHAS. WOODS.——Laredo, Tex. Pipe is being delivered for the new works.——Johnson City, Tenn. Works are being built by C. K. McCallum and others.——Watertown, Dak. The water-works project was carried unanimously April 19.——Newport, Ark. The Newport Water Co. has completed the works; the pumps have a daily capacity of 2,500,000 gals; there is a stand-pipe and 53 hydrants; the company has a capital of $100,000.

Russell Springs, Kan. Address J. E. HILLS.——Littlestown, Pa. Address E. MYERS.——Bessemer, Ala. Address the Bessemer Land & Improvement Co.——West Superior, Wis.——Skowhegan, Me.——Hinesville, Ga.——Bryan, Tex.——Staunton, Ill.——Aiken, S. C.

Spring Valley, Cal.—The Spring Valley Water Co. will issue bonds for $5,000,000; between $1,000,000 and $2,000,000 will be used in constructing a stone dam at the mouth of the cañon of the San Mateo creek, and $1,000,000 for the floating indebtedness of the corporation.

Joliet, Ill.—The U. S. Supreme Court has affirmed Judge Blodgett's decision declaring the Starr contract valid, requires the water-works company to proceed with the work and fulfil its conditions, prevents the city from interfering, and compels the city to accept the works when the terms of the contract have been complied with.

Haverstraw, N. Y.—The report of the treasurer of the Haverstraw Water Co. shows that the receipts during one year's operation were $1,940 over and above all expenses and interest on the bonds. There is a good prospect of increase during the coming season. The water was let into the pipes in April, 1886.

Bursting of a Water Tank.—A large water tank, with a capacity of 100,000 gals., near Palatine, Ill., burst April 17. A crowd was standing under and around it, viewing the wreck of a freight train on the Chicago & Northwestern R. R., and six persons were killed, two fatally injured and a number more or less seriously injured. It is supposed that the shock of the collision jarred the tank, and loosened or cracked the hoops.

Lincoln, Neb.—A report has been made by C. C. BURR to the effect that the proposed plan for an increased supply by bringing the "second water" from about two and a half miles southwest of the city through an underground pipe by gravitation is entirely feasible. A 12-in. driven well will be sunk and is estimated to give an additional supply of 500,000 gals. per day. Vitrified pipe is proposed for the mains. JOSEPH BURNS proposes a plan which calls for a siphon arrangement and iron pipes.

Sewerage.—Rochester, Minn. The Council has decided to engage an engineer to make plans and estimates for a system of sewerage.——Alameda, Cal. The automatic flushing system has been adopted, and the sewers are flushed several times daily. Smaller sewers are reported to be laid now than formerly.——San Francisco, Cal. Col. GEO. E. WARING, who has been in San Diego to design a sewerage system, will be asked to make an inspection of San Francisco and report upon an improved system, the necessity for which is strongly urged.——Sandy Hill, N. Y. A sewer is to be built on Main street.——Lincoln, Neb. Sewer extensions are to be built.

Jamaica, L. I.—The Jamaica Water Supply Co., JOHN LOCKWOOD, President, has closed a contract with the authorities to put in water-works. Six miles of pipe will be laid and the hydrant rental will be $2,000. The works will be commenced immediately and completed in six months. There will be two duplex, compound, Gaskill pumping engines with a daily capacity of 1,500,000 gals. each, two horizontal tubular boilers and a pump, boiler and dwelling house. A stand-pipe, 100 ft. high will be erected, and will have a capacity of 500,000 gals.

Pine Bluff, Ark.—The Water, Light & Power Co., of St. Louis, Mo., will shortly commence work on the new water-works; bricks are being delivered, and local contracts will be made for stone masonry. A site of over two acres has been purchased for the pumping station and a small park. The citizens are enthusiastic and many private fire hydrants have already been ordered. The original pipe system was to be six miles, but in view of the rapid growth of the city it has been decided to make it 8.75 miles, and there will probably be a further increase before the completion of the works. F. WM. RAEDER, Managing Engineer of the company, is located at Pine Bluff.

Greeley, Col.—A system of water supply is projected. There are seven artesian wells which are used for domestic use, but the only supply for persons not having a connection with these wells is the common well water. The well water is strongly impregnated with alkali. There is an abundant supply for fire purposes in the vicinity of the fire wells but it is difficult to get a supply to some parts of the town. It is proposed to sink an artesian well, to be a county well, at the court house; it will be 3,000 ft. deep and will cost about $6,000. The plan is under consideration by the county commissioners. Mayor GEORGE H. WEST, and Hon. J. L. BRUSH are interested.

Damages from Water Companies.—According to a Pittsburg paper the case of Beck *vs.* the Kittaning Water Co. has been non-suited. "The Kittaning Water Co. was legally incorporated, built works, furnished water for sanitary purposes for profit, and, by express contract with the borough, agreed to furnish water in sufficient quantities for the extinguishment of fires. Beck's brewery took fire, the hose companies were promptly on the ground and laid their lines, but could get no water. The fire-plugs were stopped with mud and gravel and the water was shut off all but one small pipe, too small to convey a sufficient quantity of water or create a pressure. During the fire the engineer of the water-works turned on a full head of water, but it was too late, and the building was totally consumed. Under these circumstances Beck brought suit to recover the damage he sustained by reason of the water company's negligence. When the testimony showing these facts was all in, the Court entered a judgment of compulsory non-suit, stating that under the facts presented there was no legal liability on the part of either the water company or the borough to furnish water to the citizens for fire purposes.

The decision in this case is of great importance to the citizens of all towns in the State having water-works and who rely upon the use of their water in case of fire. In nearly all the smaller towns the facts are the same as those developed in this trial, and the people who pay water tax will be surprised to learn that there is no legal responsibility upon the water company to furnish water for the extinguishment of fires." The case will probably be carried to the Supreme Court.

Proposals Open.

Court House.—Stone, cost not to be less then $75,000. THE COUNTY COMMISSIONERS, Bonham, Tex.

Bridge.—THE BELLE ISLE BRIDGE COMMISSIONERS, Detroit, Mich.

Machinery.—Eight batteries of boilers of 400 H. P., including all fixtures: eight engines of 200 H. P. and eight engines of 150 H. P. Brick, mortar and labor furnished. SOUTHERN COTTON OIL CO., Charlotte, N. C.

Stone and Gutters.—THE CITY CLERK, Syracuse, N. Y. May 2.

Railroad.—Grading and ties for the Melrose & Micanopy R. R. from Campville to Rochelle. R. J. CAMP, Campville, Fla. May 2.

Sewers.—Sewer pipe (12 and 15-in.), corner basins, side basins, manholes, etc. Plans and specifications at the office of the City Surveyor. JOHN HUNKELE, Street Commissioner, Newark, N. J. May 3.

At Toronto. Plans and specifications at the office of the City Engineer. WM. CARLYLE, Chairman, Committee on Works, Toronto, Canada. May 3.

City Work.—Sewers (15 and 18-in. pipe), grading, paving, curbing, and boardwalks. E. M. BIGELOW, City Engineer, Pittsburg, Pa. May 3.

Trenching.—Trenching and refilling for 4-in. and 6in. water mains. RUDOLF EICKEMEYER, President, Board of Water Commissioners, Yonkers, N. Y. May 5.

Steam Pipe, Fittings, Etc.—THE DEPARTMENT OF PUBLIC CHARITIES AND CORRECTION, 66 Third avenue, New York City. May 6.

Lumber and Supplies.—THE DEPARTMENT OF PUBLIC CHARITIES AND Correction (as above). May 6.

Street Work.—Paving, sidewalks, gutters and curbs, on about seven miles of streets. WILLIAM LUDLOW, Engineer Commissioner, Washington, D. C. May 7.

Beacons.—Two groups of beacons and two single beacons in Pensacola, Blackwater and Santa Maria de Galvaez bays, Florida. Major W. H. HEUER, U. S. Light House Engineer (7th and 8th Districts), New Orleans, La. May 7.

Iron Bridge.—W. M. KEY, Georgetown, Tex. May 9.

Wooden Bridge.—Over Isle of Hope causeway. (Bids received April 12 rejected). JOHN R. DILLON, Clerk of Chatham County, Savannah, Ga. May 9.

Street Work.—Grading street next to Mississippi river to a top width of 33 ft., with necessary shore protection and culvert. L. W. RUNDLETT, City Engineer. R. L. GORMAN, President, Board of Public Works, St. Paul, Minn. May 9.

Wire Fence.—About 10,300 ft. Price for labor alone, material alone, or work complete. Bids for labor and for work complete per 100 lin. ft. A. J. MCGONNIGLE, Chief Quartermaster, U. S. A., San Antonio, Tex. May 10.

Building.—Museum of Art. COLLINS B. HUBBARD; Secretary Trustees of Museum of Art, 48 Moffat Block Detroit, Mich. May 10.

Building Extension.—Extension and raising of wings, new rooms, iron cornices and gutters, etc, W. R. RODES, Superintendent, Missouri State Lunatic Asylum, Fulton, Mo. May 10.

Steam Fire Engine,—Capacity 500 gals., weight, 6,000 pounds, all latest improvements, reserve engine in part payment. J. ALEX. PRESTON, President, Fire Commissioner, Baltimore, Md. May 10.

Jail and College.—Jail, with residence, cost not exceed $7,000. bidders to submit plans; also college, in accordance with plans. T. L. LANIER, Chairman, Waverly, Tenn. May 10.

Dredging.—Pier No. 19 (west), 9,000 cu. yds; No. 43 (east) 3,100; No. 44 (west) 3,100; bulkhead between Nos. 43 and 44, 1,000 cu. yds. THE DEPARTMENT OF DOCKS Pier "A," North river, New York City. y 11

Sea Wall.—Stone embankment, 112,400 tons; earth embankment, 88,900 cu. yds., wharf, 60,000 sq. yds.; iron work, etc. MARSDEN MANSON, Chief Engineer. THE BOARD OF HARBOR COMMISSIONERS, San Francisco, Cal. May 12.

Lanterns.—Materials for the construction of 11 fourth order lanterns. First Lieut. JOHN MILLIS, Light House Engineer (3rd District), Tompkinsville, N. Y May 18.

Hospital and Wharf.—At Widow's island, Penobscot bay, Me. Separate bids. HON. WILLIAM C. WHITNEY, Secretary of the Navy, Navy Department, Washington, D. C. May 21.

Harbor Work.—Repairs at the Harbor of Port Clinton, O. Major L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O. May 23.

Contracting.

Engine Foundations.—The following proposals have been received by JOHN WHITELAW, Superintendent and Engineer, Water-Works Department, Cleveland, O.: Andrew Doll, Jr., $6,975; Frank Hostering, $6,990; James Hill, $7,154; V. A. Horrocks, $7,212; Julius Schulze, $7,800

The Hall Steam Pump Co., of New York City, has been awarded by the city of Philadelphia, at the recommendation of the Franklin Institute, the John Scott medal and premium, for its duplex steam pump.

The Water & Gas Works Construction Co., of Pittsburg, Pa., closed its affairs on Jan. 17, of this year, and is now out of business.

Sewer Construction.—At Owen Sound, Ont., work has been resumed on the sewers. W. Robinson, the contractor, has purchased the patent right for Canada of the Carson trenching machine, and is using the machine for the construction of these sewers.

Light House.—The following proposal for rebuilding the light-house on Marquette breakwater was received, April 23, by Major S. M. MANSFIELD, U. S. Light-House Engineer, Detroit, Mich.: John Strong, Marquette, Mich., $2,175.

Dredging.—The following proposals for work in the Kentucky river were opened April 23 by Major JAMES C. POST, U. S. Engineer Office, Cincinnati, O.: Coal Transfer & Dredging Co.; dredging, 36 cts. per cu. yd.: placing dredged material behind dams, 14 cts. per cu. yd. additional. B. L. Wood, Jr., 32 cts. and 20 cts.

Elevators.—The following proposals for elevators were opened April 23 by EDWARD CLARK, Architect U. S. Capitol, Washington, D. C.: Crane Bros., Chicago, $6,345; Ellithorpe Co., Chicago, $8,247; Stokes & Parrish, Philadelphia, $8,450; Whittier Co., Boston, $8,618; Otis Bros., New York, $10,480.

Bridge Abutments.—The following proposals for abutments for bridge at Wood island, were opened April 22 by the Park Commissioners, Boston; Sylvester & Rowe, Boston, $28,977; Hugh Nawn & Son, Boston, $32,724.90; Boynton Bros., Boston, $38,165.

City Work.—At a meeting of the City Council, Cedar Rapids, Ia., on April 22, a 2 per cent. tax was voted for paving the principal streets with cedar blocks, and bids for the work will be asked for at once. The Committee on Sewers is receiving bids for the new sewers. A large amount of paving, sewer work and extensions of the water system are contemplated for the current year.

Drain Pipes.—The following proposals for furnishing and laying drain pipes were opened April 25 by the Commission for the Construction of the Congressional Library Building, Washington, D. C.: James Ragan, $8,349; Wm. Rothwell, $9,850; Jas. F. Brien, $10,487; J. I. Atchison, $12,485.87; Bride & Murphy, $13,997.

Dredging.—The following proposals for dredging in East Chester creek, N. Y., were opened April 21 by Lieut. Col. D. C. HOUSTON, U. S. Engineer Office, New York City; Frank Pidgeon Dredging Co., New York, 26.9 cts. per cu. yd.; Hartford Dredging Co., Hartford, Conn., 47 cts.; A. J. Beardsley & Son, Bridgeport, Conn., 49.5 cts.

Terra Cotta Supplies.—The following proposals for terra-cotta material were opened recently by WILLIAM LUDLOW, Engineer Commissioner, Washington, D. C.: Potomac Terra-Cotta Co., 8, 12, 15 and 24-in. pipe, 10¼, 21, 30 cts. and $1.20 per ft.; branches 8x6-ins., 12x6 ins. and 24x6 ins., 35 cts., 36 cts., $2; 6-in. thimbles, 10 cts. American Sewer Pipe Co., pipe, 10, 16, 25 cts. and $1.30; branches, 17 cts., 32 cts. and $2.50. A. Lamond 8-in. and 12 in. pipe, 11½ and 21 cts.; branches 12x6 ins., 39 cts.; thimbles, 10 cts.

Sewers.—Syracuse, N. Y. Contracts have been awarded as follows: Anthony McNamara, 18-in. tile sewer, $551.03; Martin & Sprague, 24-in. tile sewer, $2,655. ——Binghamton, N. Y. The proposals for the Chapin street sewer were: John C. Smith, Buffalo, $2,180; C. O. Root, Binghamton, $2,317.45; E. A. Matthews, Binghamton, $2,367; contract awarded to John C. Smith.—— Springfield, Mo. The city will expend $200,000 in the construction of a sewerage system.

Water-Works.—F. R. Durfey, of Norwich, Conn., has a contract for putting in water-works at Bath, Me., and will take up his residence at that place till the fall.—— M. Talcott has the contract for the water-works for Eastport, Me.——H. B. Leach & Co., of Philadelphia, have the contract for pipe laying at Phenix, R. I.——M. P. Kelly & Co., of St. Louis, Mo., have the contract for the water-works at Greenville, Tex.; they will cost about $75,000.

Dredging.—The following proposals for dredging in the harbor, dock, and middle branch at Baltimore, Md., were opened April 25 by N. H. HUTTON, Engineer to the Harbor Board: L. J. Fobes, Baltimore; channels and harbor, 13½ cts. per cu. yd.; back basin and docks, 17¾ cts.; Spring gardens, 14¾ cts.; clay and sand, 32 cts. Canton Dredging Co., Baltimore; 14, 17, 15 and 32 cts. Baltimore Dredging Co., Baltimore; 13½, 17, 14½ and 30 cts. Chas. W. Nelson, Jr., 13¾, 17¾, 14½ and 35 cts. Proposals were asked for dredging and redepositing material behind sea wall, an average distance of 300 ft., and for dredging and redepositing material in the river or bay, where approved by the Board; the bids were all for the latter disposition of the material. The appropriation for dredging channels, harbor, basin and docks, is $45,000, and for Spring gardens $5,000.

Jetty.—The following proposals for the construction of a jetty at the entrance to Galveston harbor were opened April 16 by Major O. H. ERNST, U. S. Engineer Office, Galveston, Tex.: A. M. Shannon & Co., Galveston, Tex.; 41,500 cu. yds. riprap, $2.60 per cu. yd.; 36,600 cu. yds. of stone blocks weighing from one to two tons, $4.40 per cu. yd.; 16,300 cu. yds. clay, $1.70 per cu. yd.; total, $296,650. Gustav Wilke & John W. Bickey, Austin, Tex.: $2.90, $4.73, $1.20, $313,028. Louisiana Jetty & Lightering Co., New Orleans, La.; $2.85, $4.80, $1.55, $319,220. T. J. League, Galveston, Tex.; $3.58, $5.86, $1.75, $391,571. John Satterlee, Englewood, N. J.; $4.28, $5.88, $3.98, $457,702. Charles Clarke, Galveston, Tex.; $5.05, $6.24, $2.08, $471,863. Rittenhouse Moore, Mobile, Ala.; $4.54, $7.70, $1.50, $494,680. The contract was awarded to A. M. Shannon & Co.

Construction Material.—The following proposals were opened April 22 by WILLIAM LUDLOW, Engineer Commissioner, Washington, D. C.: Westhaven Granite Co., granite paving blocks, $45 per 1,000. Richmond Granite Co.; granite paving blocks, $46.50 for first 100,000; $47 for the second 100,000. Virginia State Granite Co.; granite paving blocks, $40.85 per 1,000. New York & Maine Granite Paving Block Co.: granite curb, 6 x 20-in. straight and circular, 95 cts. and $1.40 per ft.; 8 x 8-in. straight and circular, 93 cts. and $1.40 per ft.; granite paving blocks, first 67,000, $39.75; second 67,000, $41.75; third 66,000, $42.75. Brandywine Granite Co., Wilmington, Del.; blue stone curb, 5 x 20-in. straight and circular, 50 cts. and $1 per ft.; granite curb, 6 x 20-in., 93 cts. and $1.86; 8 x 8-in., 74 cts. and $1.48. Acker & Co.; (same materials), 78½ cts. and $1.05; $1 and $1.55, $1 and $1.55; dressing curbs, 38 cts. per ft. G. Creany; dressing curbs, 20 cts. per ft. Washington Brick Machine Co., paving bricks, $8.23 and $9.23 per 1,000; arch bricks, $7.23 per 1,000. Hastings Pavement Co., New York City, asphalt paving blocks, $71 per 1,000; asphalt tile, $60 per 1,000.

The Ingersoll Rock Drill Co. reports the sale to SHEPARD, WINSTON & Co., for the Galena tunnel on the Chicago, Burlington & Northern extension, of two straight-line air-compressors, with air-receiver, etc., and 12 Eclipse rock-drills with fittings. Also 2 compressors, and 16 drills for the Wickes tunnel, in Montana, 6,100 ft. long, 16 by 20 ft.; 1 compressor, and two drills to the Prize Mining Co., of Central City, Colorado; 1 compressor, and 4 drills to the Printau Mining Co., Bessemer, Mich., and 1 compressor, and 10 drills to the Colby mine in Bessemer also. Tunneling seems to be booming, as the INGERSOLL CO. reports more sales of mining machinery in March last, than in any month since it has been in business, and says that the sales for April promise to be even greater still.

Street Work.—Columbus, O. The City Council has authorized a considerable amount of street work; stone block, fire-clay brick, and asphalt paving; grading, curbing, guttering, graveling, etc.——Springfield, Mo. The streets are to be graded, and macadamized or paved, at once.——Atchison, Kan. W. H. Duffett, of Leavenworth Kan., has the contract for paving Commercial street with bois d'arc blocks.——St. Paul, Minn. Contracts have been awarded as follows; grading; Cooper & Harper, $8,460, $8,100; hexagonal block stone walk, Eureka Stone Co., 18 cts. per sq. ft., $33,285. Estimates have been prepared for a large amount of street work.——Richmond, Mo. A vote will be taken May 10 on the proposition to issue bonds for $25,000 for street grading and macadamizing.——Little Rock, Ark. Contracts aggregating $6,206 have been awarded for about one mile of sidewalk.——Oakland, Cal. It is proposed to pave some of the streets with Santa Cruz asphaltum.

Sault Ste. Marie Bridge.—The contract for the superstructure of the new railway bridge over the Ste Marie river has been awarded to the Dominion Bridge Co., Lachine, Que.; and for the 400 ft. draw span, which will be operated by steam, to the Detroit Bridge & Iron Works, Detroit, Mich. P. ALEX. PETERSON, Montreal, is Chief Engineer.

Harbor Work.—The following proposals for building the breakwater and enlarging the inner harbor at Block Island, R. I., were opened April 21 by Major LIVERMORE, U. S. Engineer Office, Newport, R. I.: Wm. H. Molthrop & Co., New London, Conn.; hard pine timber, $40 per 1,000 ft. B. M.; hard pine plank, $43 per 1,000 ft. B. M.; wrought-iron, 7 cts. per pound; wrought-iron spikes, 7 cts. per pound; beef or pork barrels, $2.50 each; rip-rap granite, $1.59 per ton; total $17,314. James Scully, Groton, Conn.; $37,, $37, 10 cts., 10 cts., $2, $1.59, $17,315.40. John A. Bouker, New York; $60, $60, 10 cts., 10 cts., $3, $1.61, $17, 753. Chas. H. Edwards, Quincy, Mass.: $50, $55, 10 cts. 8 cts., $2, $1.64, $17,955.——For similar material for the construction of jetties at Westport harbor, Mass.: Wm. H. Molthrop & Co., New London, Conn.; $55, $55, 8 cts., 8cts., $5, $3.80, $1,298.10.

Bridge Contracts.—The Pennsylvania Construction Co. has been awarded the contract for two bridges for the county commissioners at Connellsville, Pa., at $7.25 per ft.——Crumbo & Melcher, Indianapolis, Ind., have been awarded the contract for the bridge over Silver creek, on the New Albany & Eastern extension of the Ohio & Mississippi R. R.; the bridge and trestle approaches will be 1,000 ft. long.——Van Wagner & Degann, of Syracuse, N. Y., have been awarded the contract for the construction of seven four-track bridges near Newark, N. Y., for the New York Central R. R.; the work will cost about $35,000. The contract for a wooden bridge at Marietta, Ga., has been awarded to C. C. Sawell, of Acworth, for $175. The King Iron Bridge & Manufacturing Co., of Cleveland, O., bid $950 for an iron bridge.

Ditch Work.—The following proposals for excavating the Birk ditch from station 140 to 400, and the Grisi ditch from station 120 to 255, were opened April 25, by W. M. WHITTEN County Surveyor and Drainage Commissioner of St. Joseph county, Ind., and City Engineer, South Bend, Ind.: John Hughes, Plymouth, Ind., (Birk) 10 cts. per cu. yd., (Grisi) 8.9 cts. W. B. Albright, Hartford City, Ind., 10.8 cts. Sutherland & Kline, Blair, Neb., 11.49 cts. W. A. McGillis & Co., Easton, Ill., 11.5 cts. M. Kelley & Co., Crawfordville, Ind., (Birk) 140 to 240, 12 cts; 240 to 400, 14 cts.; (Grisi) 11 cts. Dennis O'Connor, South Bend, Ind., 12.5 cts. John Cahill, South Bend, Ind., 13 cts. Thomas McCarthy, South Bend, Ind., 13 cts. John Van Patton, West Troy, N. Y., 13.5 cts. J. C. Honck, South Bend, Ind., 14 cts. W. H. Wheeler, Ashkum, Ill., 15 cts. Frank Gohm, North Liberty, Ind., 16 cts. W. H. Farren, South Bend, Ind., 20 cts. John M. Hogan, Mishawaka, Ind., 21 cts. Peter Johnson Brown, Cleveland, O., 28 cts. The contract was awarded to John Hughes.

Valves and Pipe.—The following proposals have been received by JOHN WHITELAW, Superintendent and Engineer, Water-Works Department, Cleveland, O.: Valves (seven 30-in. and six 36-in.); Jas. Flower & Son, Detroit, Mich., $3,550, $5,500; Eddy Valve Co., Waterford, N. Y., $2,275, $3,990; Coffin Valve Co., Boston, Mass., $2,450, $3,350; Murdock Valve Co., Detroit, Mich., $3,325; no bid; G. Worthington & Co., Cleveland, O., $2,380, $2,900; Chapman Valve Co., Indian Orchard, Mass., $2,499, $3,614; Whittier Machine Co., Boston, Mass., $2,940, $5,390.

Water pipe across the Cuyahoga river: Cleve Steam Boiler Works, $4,570; Variety Iron Works, $4,682.

Railroad Contracts.—Nelson Bennett, of Tacoma, Wash. Ter., has the contract for constructing 63 miles of the Spokane & Palouse R. R. in the Territory; he graded 42 miles of this line last year.

The United States Railway Improvement Co. has the contract for the construction of the Central Missouri R. R.; the line will run from St. Charles, Mo., to Kansas City, crossing the Missouri river between Lisbon and Arrow Rock. It will be extended east to Alton.

P. H. Bennett, Fairmount, W. Va., has a contract for building ten miles of railroad.

Larson, Keefe & Co., who have the contract for the Montana Central R. R., have commenced work on both ends of the Wickes tunnel; Ingersoll drills will be used. Sub-contracts are being let for other work.

Mason, Hoge & Co., Louisville, Ky., have the contract for grading the Louisville, St. Louis & Texas R. R., between West Point and Owensboro; the entire line from Louisville to Henderson, 136 miles, will soon be under contract.

The Kentucky Union R. R. will soon be under contract. For information address F. D. CABLEY, of Louisville, Ky.

The Long Island R. R. Co. will let the contracts for its four mile extension from Locust Valley to Oyster Bay, L. I., as soon as the right of way has been secured, which work is now in progress. ANTHONY JONES, Brooklyn, is Chief Engineer.

Bridges, Canals, Etc.

Natural Gas in Ohio.—During the past 16 months 182 natural gas and oil companies have been incorporated in Ohio with an aggregate capital stock of $9,262,978. Applications for new charters are coming into the office of the Secretary of State at the rate of two or three a day.

Shoals at the Mouth of the Mississippi.—It was reported at the meeting of the New Orleans Maritime Association on April 21 that at two points in the South Pass there had been during March and the early part of April a serious shoaling in the channel, less then two miles from the head, where it widens to double its usual width during the high water. Lumps formed in such locations as to make it impossible for deep ships to pass without touching them, and as the channel here deviates from a straight line, vessels on touching bottom are apt to sheer into the east bank and stick fast. Further down there is another widening of the pass at Grand Bayou. Here shoals were also reported. It seems probable that shoals will form at these two points with each high river unless suitable works are erected to prevent them. At the entrance to the jetties there is no lack of water.

Railroads.

The Abt Rack Rail System.—Mr. ABT has received an order from the Indian government for seven miles of railway, with a three bar rack, switches, entering rails and engines complete. The line will be on the 5 ft. 6 ins. Indian gauge. The engines are to be of the heaviest type, and the first one is to be shipped ready for use from Antwerp by August 25. Mr. ABT has prepared some interesting data respecting the wear of the rack bars and pinions. Mr. OTTO GRUNINGER, C. E., New York, is the representative of the system for this country.

Railways in Persia.—The German government has appointed a permanent consulate in Persia, and hopes thus to favor the trade with that country. Several projects have been made for railways, as a line from the Persian gulf to the interior would prevent the monopoly of Russia's railway system in Asia; thus far all concessions have been refused but it is hoped the Persian government can be convinced of the importance of railways. Reuter's project was for a line from Resht, on the Caspian sea, through Teheran, Ispahan, and Shiraz to Bushir, on the Persian gulf, but so many privileges were asked that the Persian officials defeated the scheme.

Rapid Transit.—Brooklyn, N. Y. The Kings County Elevated Railway Co. and the Union Elevated Railroad Co. are both at work on their respective lines.—Pittsburg, Pa. The Pittsburg Traction Co. has been organized with a capital stock of $2,500,000. President, GEO. W. ELKINS, Philadelphia.—St. Louis, Mo. A number of cable lines are projected.—Pomona, Cal. A cable line, 13 miles long, is contemplated, and S. H. TERRY, inventor of the Terry cable system, has been applied to. Address Judge THOMAS B. NESBIT for information.—Providence, R. I. The Providence Cable Tramway Co. and the Union Railroad Co. have decided not to build the East Side cable line until next spring. It has been decided to adopt the Johnson system, as used in Brooklyn, N. Y.—Cincinnati, O. Work is in progress on the Vine street cable line.—Chicopee Mass. It is proposed to run the cars by electricity between Chicopee Falls and Springfield; work will soon be commenced on the tracks. R. S. BROWN is Chief Engineer.

Venezuela Central Ry. Co.—This company has been organized in England to carry out a concession granted by the Venezuelan government to REGINALD PRINGLE, C. E., for a railway from Caracas, which has railroad communication with the coast, through Santa Lucia, La Victoria and Maracoy to Valencia, where it will connect with a line now being constructed to the port of Puerto Cabello, 33 miles distant. The first section, from Caracas to Santa Lucia is 33 miles, and the section thence to Valencia about 105 miles; total, about 138 miles. The contract for the construction and equipment of the line has been awarded to J. E. & M. Clark & Co., of London, who are contractors for a number of public works in South America. WM. ROBERTS, of London, is Chief Engineer.

Grading and Tracklaying.—*East of Chicago.*—The York Harbor & Beach R. R. from Kittery, on the Boston & Maine R. R., to York Beach, is to be graded and ready for tracklaying by July 1, and will open for traffic a month later. The line is eleven miles in length, and has a mile and a half of trestling and much heavy rock work.—Pontiac Pacific Junction Ry. Grading has begun on the extension from Coulonge to Pembroke, Ont., 25 miles. R. M. BERRIAN is Chief Engineer. The line will eventually reach Sault Ste. Marie.

Clarendon & Pittsford R. R. Grading is in progress on this line, located in Rutland Co., Vt. It is to be 20 miles in length, and is expected to be open for traffic by October. The Vermont Marble Co. will build, own, and operate the line. FRED R. PATCH is Chief Engineer.—Nascopec, R. R. The branch of the Pennsylvania R. R., extending from Nascopec, Pa., to Rock Glen junction, 11.6 miles, has been completed and opened for traffic.—Hartford & Connecticut Western R. R. The new line from Poughkeepsie to Jackson Corners, 28 miles, has been located, and grading is to begin at once.—The Vandalia South Branch Ry. from Brazil to Saline City, Ind., is completed.

The Northwest.—Illinois Central R. R. On the Chicago, Madison & Northern line, track is laid to near Monroe, Wis. On the Freeport & Chicago line, a large force of graders are at work.—Chicago, Milwaukee & St. Paul Ry. Grading begins May 1 on the line from Merrill, Wis., to Tomahawk Lake.

The Southwest.—Central Missouri R. R. Grading has begun at St. Charles, Mo.—Missouri Pacific. On the Kansas & Arkansas Valley line, track is laid from Van Buren, Ark., to Lee's creek, 20 miles.—The last spike on the new Santa Fè line from Kansas to Texas was driven at Purcell, Ind. Ter., April 26. The Gulf, Colorado & Santa Fé Ry. was consolidated with the Atchison, Topeka & Santa Fè one year ago and extensions to form a connecting line were begun by both companies, the former from Fort Worth, Tex., and the latter from Arkansas City, Kansas. The last 42 miles of track on the Gulf & Colorado extension, was laid in 26 days. By this connection the Santa Fè system gains over 700 miles of road and is placed in direct communication with all principal points in Texas.

Southern.—Georgia, Midland & Gulf R. R. Grading is completed from Columbus to Griffin, and over 50 miles of track is laid. The line from Griffin to McDonough is being pushed.—Savannah, Florida & Western R. R. Work has begun on the extension from Thomasville, Ga., to Tallahassee, Fla.—Grading is in progress on the Jeanerette, Abbeville & Western R. R. in Louisiana.—Raleigh & Augusta Air Line R. R. About four miles is graded on the branch from Cameron, N. C., to Carthage.

Georgia, Southern & Florida Ry. This line, which has been surveyed from Macon, Ga., to Gainesville, Fla., will be constructed at once, sufficient capital having been secured.—Louisville, St. Louis & Texas R. R. 88 miles of this line, from West Point to Owensboro, Ky., are now under construction.

The Southwest.—Denison, Bonham & New Orleans R. R. Work is to be commenced at once.

Rocky Mountain and Pacific.—Union Pacific Ry. A branch is completed from Loveland, on the Colorado Central R. R. to Buckhorn, 10 miles.—Southern Pacific Ry. Work on the line between Ashland, Oregon, and Edgewood, Cal., is in progress. There is much tunneling and rock work through the Siskiyou range, making the work expensive and slow.

Surveys.—*East of Chicago.*—The Upper Coös R. R., from Colebrook, N.H., to North Stratford, on the Grand Trunk Ry., 14 miles, is to be surveyed at once. J. H. DUDLEY, of Colebrook, is president.

Cannelton, Pell City & Lincoln R. R. This branch of the Louisville, Evansville & St. Louis Ry., in Southern Indiana, is being located.

Southern.—The Illinois Central R. R. is said to be in the field looking for a feasible route for a Vicksburgh extension.—Silver Springs, Ocala & Gulf R. R. A branch 4 miles in length to Parkersburgh, Fla., has been surveyed.

Athens & Jefferson R. R. The surveyors have begun work at Athens, Ga.

Minneapolis & Pacific R. R. The Short Line from Minneapolis to Anoka has been located and right of way secured.

Newport, Jonesboro' & St. Louis R. R. A surveying party has begun work at Newport, Ark.

The Northwest.—The Minneapolis & Pacific R. R. Co. has begun a survey from Elbow Lake, Minn., to Fargo, Dakota.—The Lincoln, (Neb.) Belt Line R. R. is under survey.—Chicago, Burlington & Quincy Ry. The extension from Rockford, Ill., to Madison, Wis., is under survey.

The Southwest.—The Fredonia, Howard & Southwestern R. R. is under survey from Fredonia, Kan.—Missouri Pacific Ry. Location on the Mississippi river line is completed to Cape Girardeau, Mo.—Kansas City, Springfield & Memphis R. R. The Current river line is cross sectioned, and grading will begin at once.

Rocky Mountain and Pacific.—The St. Paul, Minneapolis & Manitoba R. R. has sent a reconnoisance party into the Rocky mountains to look for a feasible pass for a Pacific extension.—Denver & Rio Grande R. R. Under the name of the San Juan Ry. Co., it is proposed to build seven lines of road in southwestern Colorado, centering at Durango. The line to Rico is already under survey.—Albuquerque, Durango & Pacific R. R. Co. An organization has been effected at Albuquerque, N. M., and the line to Durango, Col., will be surveyed at once.—Southern Pacific Ry. The branch line to Yreka, Cal., from the California & Oregon main line, will be ten miles in length, with a maximum grade of 75 ft. per mile, and will cost $78,000. A line is under survey to Santa Rosa, Cal.—Nevada & Oregon R. R. The company has purchased material for a northern extension.—Chicago, Burlington & Quincy R. R. Rumor locates a surveying party in this company's interest, among the sage brush and alkali deserts of southern Nevada.

New Companies and Projects.—*East of Chicago.*—Worcester & Hudson R. R. Capital for construction has been obtained and most of the right of way secured. The line is 18½ miles in length, and runs through Shrewsbury and Northboro. JOHN GILMAN, of Worcester, Mass., President, informs us that the line will be built this season and will form with the Fitchburg R. R., a short route from Worcester to Boston. Mr. GILMAN also says that companies will soon be organized to construct four new railway lines from Worcester as follows: Southbridge via Brookfield to Hardwick, 24 miles; Worcester via Auburn, Southbridge and Wales to Hartford, Ct., 62 miles; Worcester via Millbury, Blackstone, and Franklin to Providence, R.I., 44 miles; Worcester to Plymouth, Mass., 60 miles.—Attica, Lockport & Lake Ontario R. R. Co. It is reported that this company, which was chartered in 1883, will construct its line from Attica to Youngstown, N.Y., this season. R. S. STEVENS, Attica, N. Y., is President.—Ohio & Northwestern Ry. The Columbus & Maysville line will be extended from Hillsboro, O., to Washington, Fayette Co.—Deer Creek & Susquehanna R.R. Co. The stockholders will elect a directory on May 18 and the line which is proposed from Aberdeen, Md., to Glen Cove will then be surveyed. JOHN H. JANNEY, Churchville, Md., is interested.

Cleveland & Southwestern Ry. Co. Incorporated by DONALD MCNAUGHTON and others, to build a line from Cleveland, to Zanesville, O.

The Canadian Parliament has before it several bills concerning projected railways. The United Counties Ry. is a line proposed from Iberville *via* St. Hyacinthe to the St. Lawrence river. The Montreal & Lake Maskinonge Ry. Co., proposes a line from St. Gabriel De Brandon to a connection with the Canadian Pacific Ry. in the parish of St. Felix des Valois. A line is also proposed from Quebec to the Saguenay.—A belt line is proposed at Youngstown, O.—A company is organizing at Malone, N. Y., to build a railroad from that place to Troy pond on the Chateagay R. R., a distance of 18 miles.

Southern.—The Memphis & Charleston R. R. will be extended from Stevenson, Ala., to Chattanooga, Tenn.—G. W. MCMASTER, Winnsboro, S. C., is interested in a proposed line from Camak, Ga., to Wadesborough, N. C.

The Northwest.—The Kansas City, Wyandotte & Northwestern R. R. Co., which has been obtaining aid and right of way along its proposed lines from its Kansas terminus to Keyapaha and Custer in Nebraska, has filed articles of incorporation in the latter State and will begin work at once.—Chicago, Milwaukee & St. Paul Ry. It is said that the extension from Merrill, Wis., will be continued north from Tomahawk Lake *via* Presque Isle river and Union Bay to Houghton, a total distance from Merrill of 225 miles.—Wisconsin, Pittsville & Superior R. R. An extension is proposed from Pittsville to Marshfield, Wis.—Illinois Central R. R. Sioux Falls, Ia., wishes the company to build a line from Cherokee.

The Southwest.—The St. Louis & San Francisco Ry Co. will build a branch from Tulsa, Ind. Ter., to connect with the new Santa Fé line.—Greenfield & Northern R. R. Co. An amended charter has been filed, permitting an extension from Greenfield, Mo., to Stockton.—Atchison, Topeka & Santa Fé Ry. A St. Louis extension is rumored *via* Ottawa and Paola, Kan., and Clinton, Mo.

Pittsburg, Calamine & Newport Ry. Co. Incorporated by A. A. MCCORMICK, Parsons, Kan., and others, to build a railway from Pittsburg, Kan., to Newport, Ark., *via* the zinc mining region in Sharp Co., Ark.

Dardanelle & Little Rock Ry. Co. Incorporated by J. K. PERRY and others, of Dardanelle, Ark., to build a railway through Yell, Perry, Conway and Pulaski counties.

Rocky Mountain and Pacific.—Southern Pacific Ry. A branch line is proposed from Martinez to Livermore, Cal., 30 miles.—Denver & Rio Grande R. R. Under the name of the Wyoming, Colorado & Pacific Ry. Co. it is proposed to build a line to Cheyenne, Wyo., from some point on the Colorado lines. The road will be built with a third rail.—Seattle & West Coast Ry. Co. Incorporated by DANIEL H. GILMAN, Seattle, W. T., and others, to build from Seattle to the boundary to connect with the Canadian Pacific Ry.—Atchison, Topeka & Santa Fé Ry. A line is proposed from the head of the Gulf of California to Yuma and Phœnix, Ariz.

New Croton Aqueduct.—The contract for the construction of Additional Shaft No. 13½, is to be awarded on Monday.